Pittsburg-Antioch Corridor

Contra Costa County, California

Alternatives Analysis/ Draft Environmental Impact Report

Vol. 2: Appendices

Prepared for:
Bay Area Rapid Transit District

Prepared by:
Bechtel Civil, Inc.
Michael Brandman Associates, Inc.
and Associated Subconsultants

August 1988

APPENDICES

PITTSBURG-ANTIOCH CORRIDOR
CONTRA COSTA COUNTY, CALIFORNIA

ALTERNATIVES ANALYSIS/
DRAFT ENVIRONMENTAL IMPACT REPORT
(State Clearinghouse Number 87111114)

Prepared for:

Bay Area Rapid Transit District

Prepared by:

Bechtel Civil, Inc.
Michael Brandman Associates, Inc.

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August 1988

COVER SHEET

PITTSBURG-ANTIOCH CORRIDOR
CONTRA COSTA COUNTY, CALIFORNIA

ALTERNATIVES ANALYSIS/
DRAFT ENVIRONMENTAL IMPACT REPORT

ABSTRACT

This document describes and summarizes the transportation impacts, environmental impacts, and costs, and provides a comparative evaluation of, the alternative transportation improvements being considered for Contra Costa County's Pittsburg-Antioch Corridor. The alternatives considered include the "no build" alternative, a transportation systems management alternative, and a number of transportation facility alternatives (high occupancy vehicle lanes, light rail transit, and an extension of the Bay Area Rapid Transit District rail transit). The information contained in this document will be used to select a locally preferred alternative for the corridor. The analysis has been prepared pursuant to the California Environmental Quality Act of 1970, as amended (state Public Resources Code Division 13, Section 21000 et seq.). In addition, the technical analysis follows federal National Environmental Policy Act guidelines.

Volume 1 of this document is the text; Volume 2 is appendices.

COMMENTS ON THE DRAFT EIR

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Written comments should be sent to Alan Lee.

Comments must be received by: September 15, 1988
Date

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Appendix A

Existing Land Uses and General Plan Station Area Land Use Designations

PITTSBURG-ANTIOCH CORRIDOR
EXISTING LAND USES AND GENERAL PLAN
STATION AREA LAND USE DESIGNATIONS

Prepared for:

Bay Area Rapid Transit District
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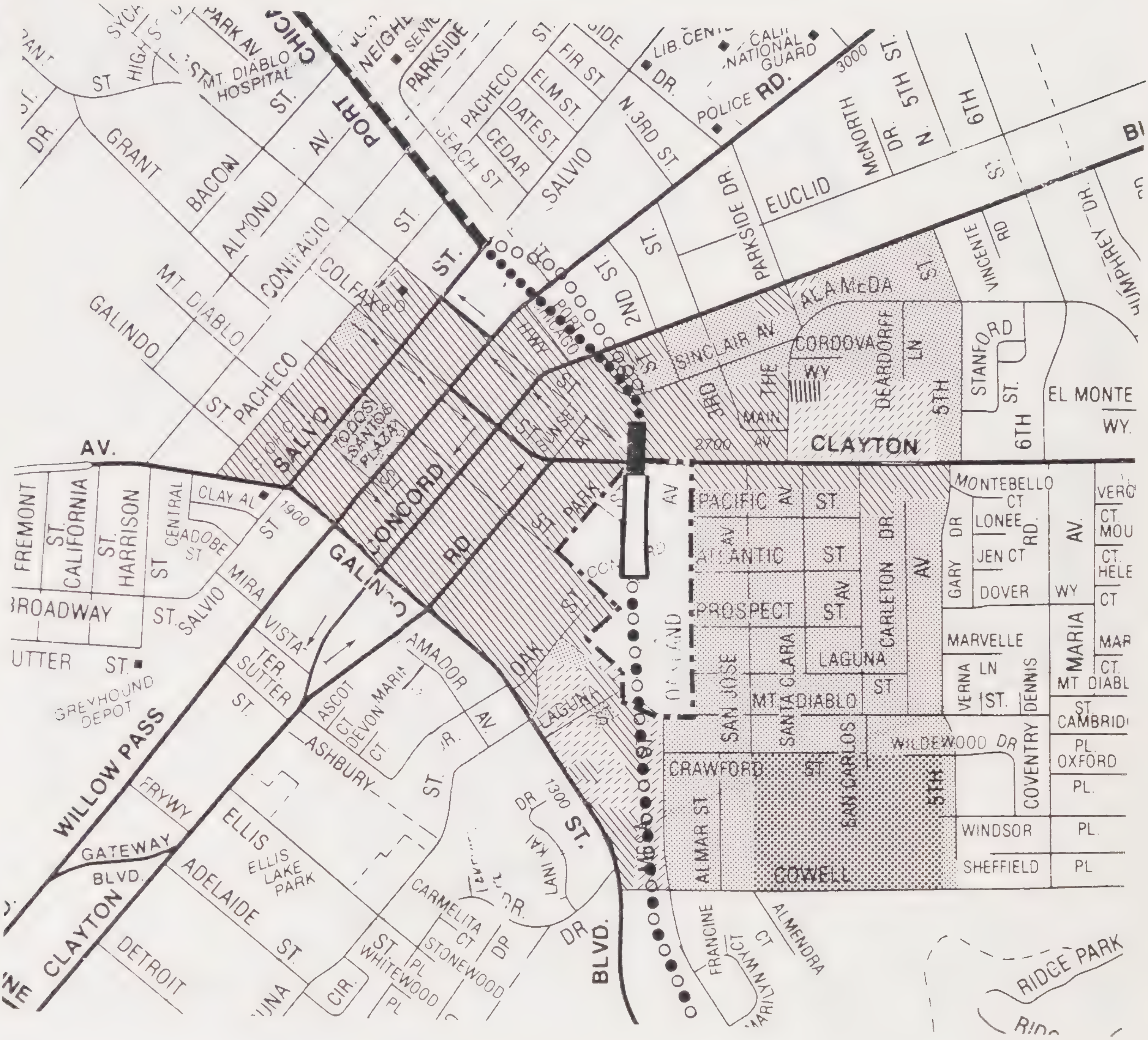
July 1988



Legend

RESIDENTIAL	PARK AND RIDE FACILITY
OFFICE/ COMMERCIAL	EXISTING BART ALIGNMENT
INDUSTRIAL	LRT ALIGNMENT
PARK	BART ALIGNMENT
SCHOOL	LRT OR BART ALIGNMENT
VACANT	LRT OR BART STATION
	LRT STATION

EXISTING LAND USES

STATION A

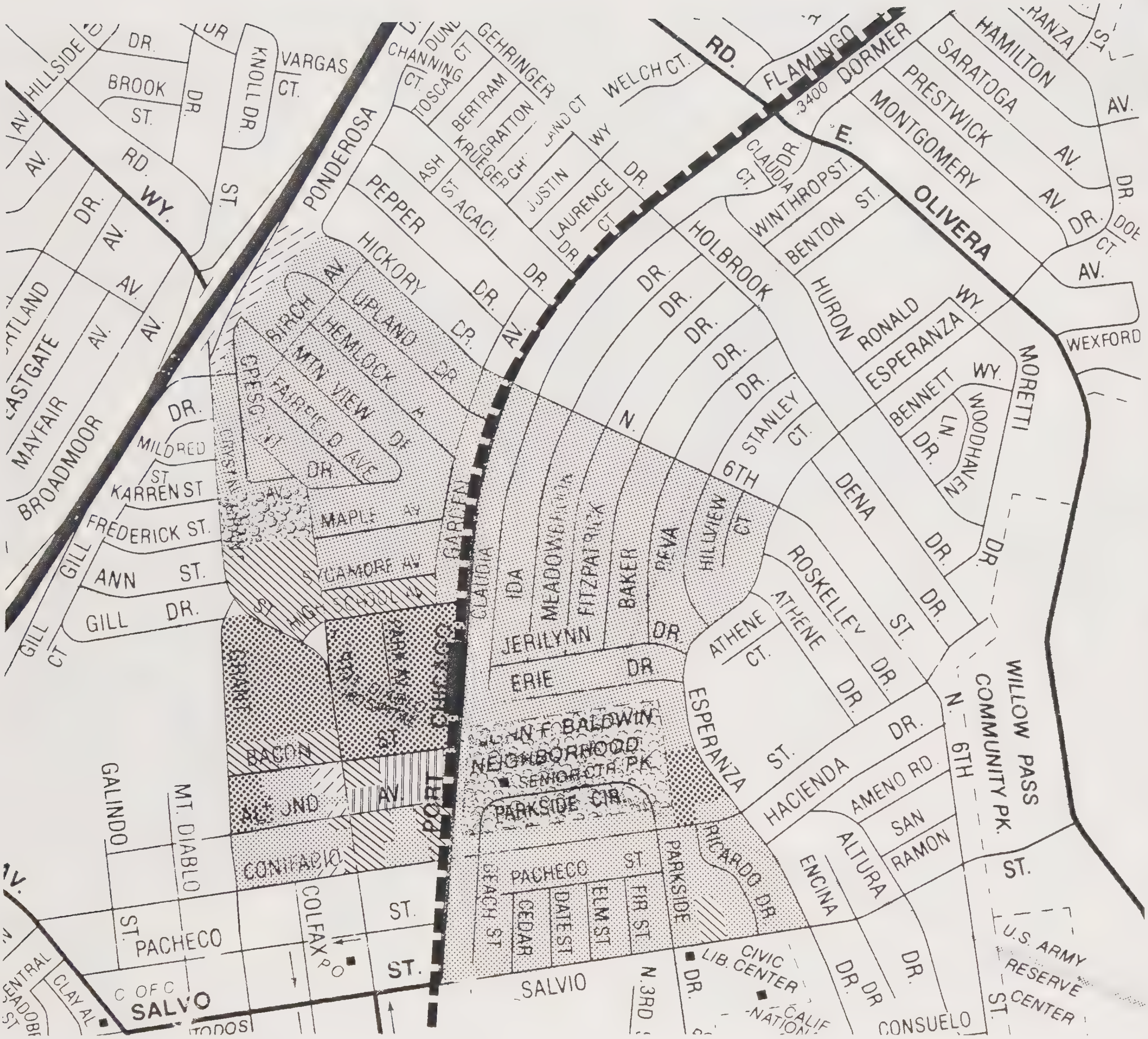
Pittsburg – Antioch Corridor AA/DEIR

North

0 500 1000 FEET

BART

Exhibit A.1



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- RESIDENTIAL
- OFFICE/ COMMERCIAL
- PARK
- SCHOOL/HOSPITAL/ CHURCH
- PARKING
- VACANT
- LRT OR BART ALIGNMENT
- LRT STATION

EXISTING LAND USES

STATION B

Pittsburg–Antioch Corridor AA/DEIR

North

0 500 1000 FEET

BART

Exhibit A.2

Legend

	RESIDENTIAL		PARK-AND-RIDE FACILITY
	OFFICE/ COMMERCIAL		LRT OR BART ALIGNMENT
	SCHOOL		LRT ALIGNMENT
	NAVAL WEAPONS STATION		BART ALIGNMENT
	PARKING		LRT OR BART STATION
	VACANT		BART TURNBACK AREA

EXISTING LAND USES

STATION C

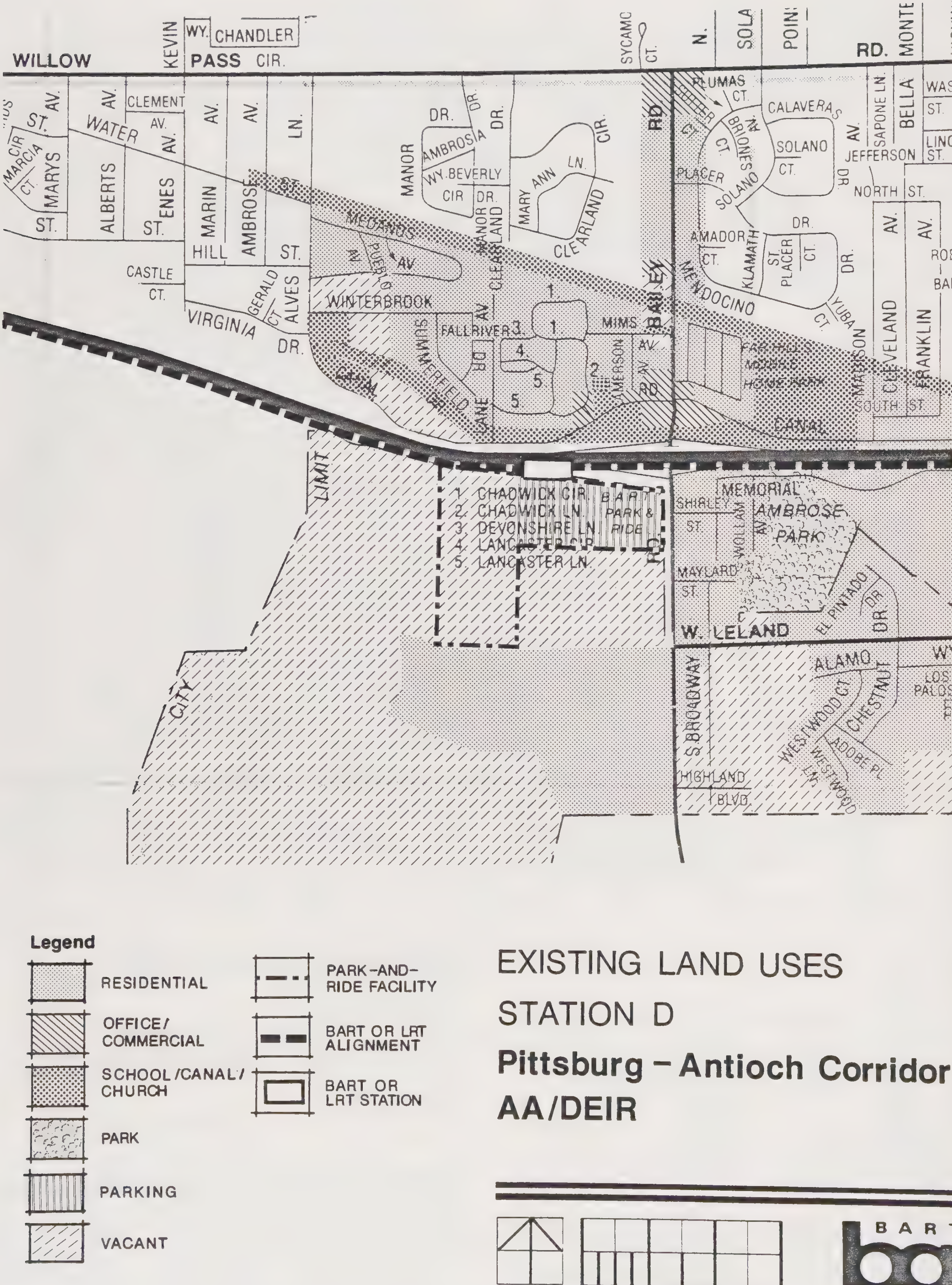
Pittsburg – Antioch Corridor AA/DEIR

North

0 500 1000 FEET

BART

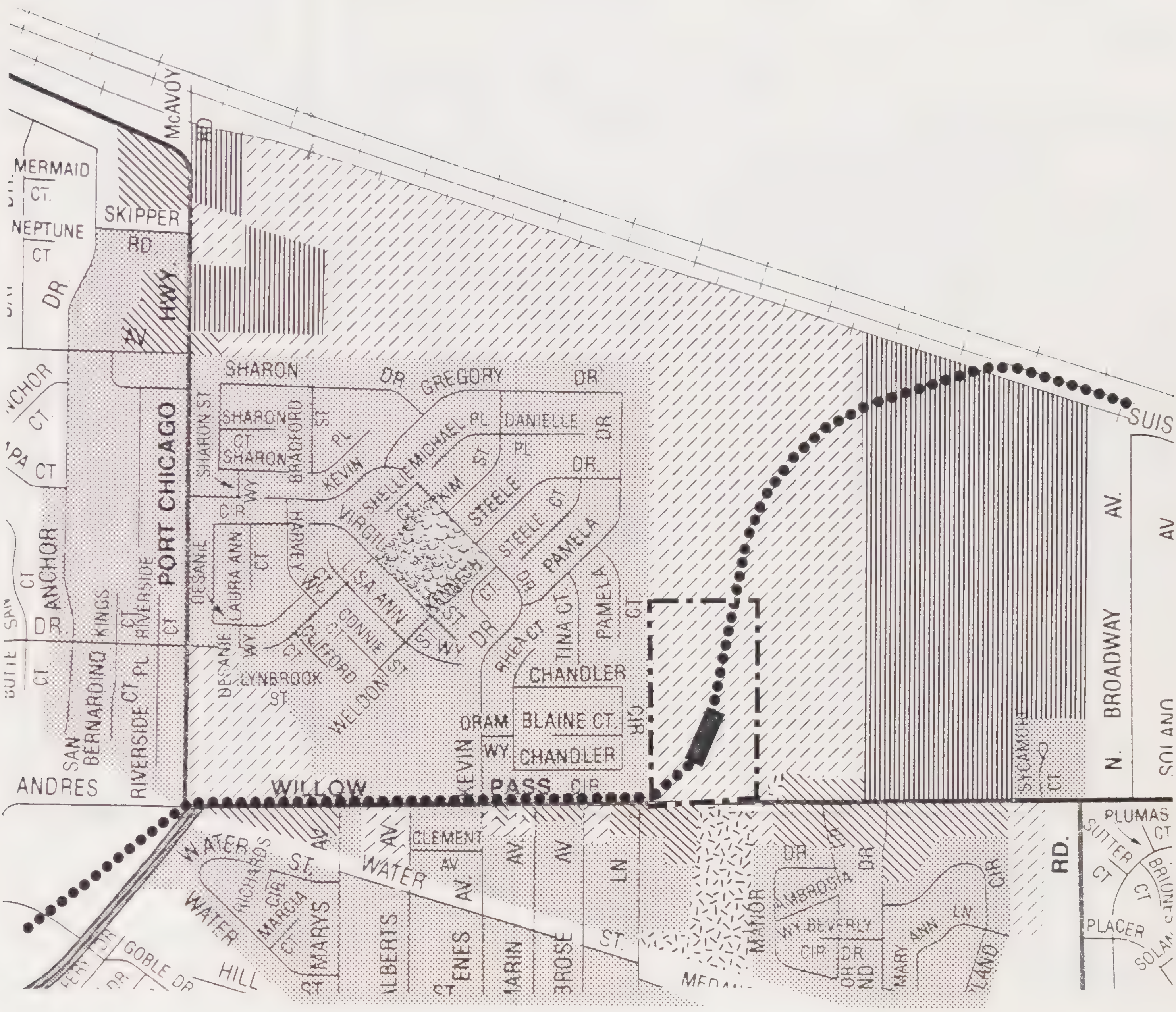
Exhibit A.3



EXISTING LAND USES STATION D

Pittsburg – Antioch Corridor AA/DEIR

Exhibit A.4



Legend

	RESIDENTIAL		PARK-AND-RIDE FACILITY
	COMMERCIAL		LRT RAIL
	INDUSTRIAL		LRT STATION
	PUBLIC FACILITY		
	PARK		
	VACANT		

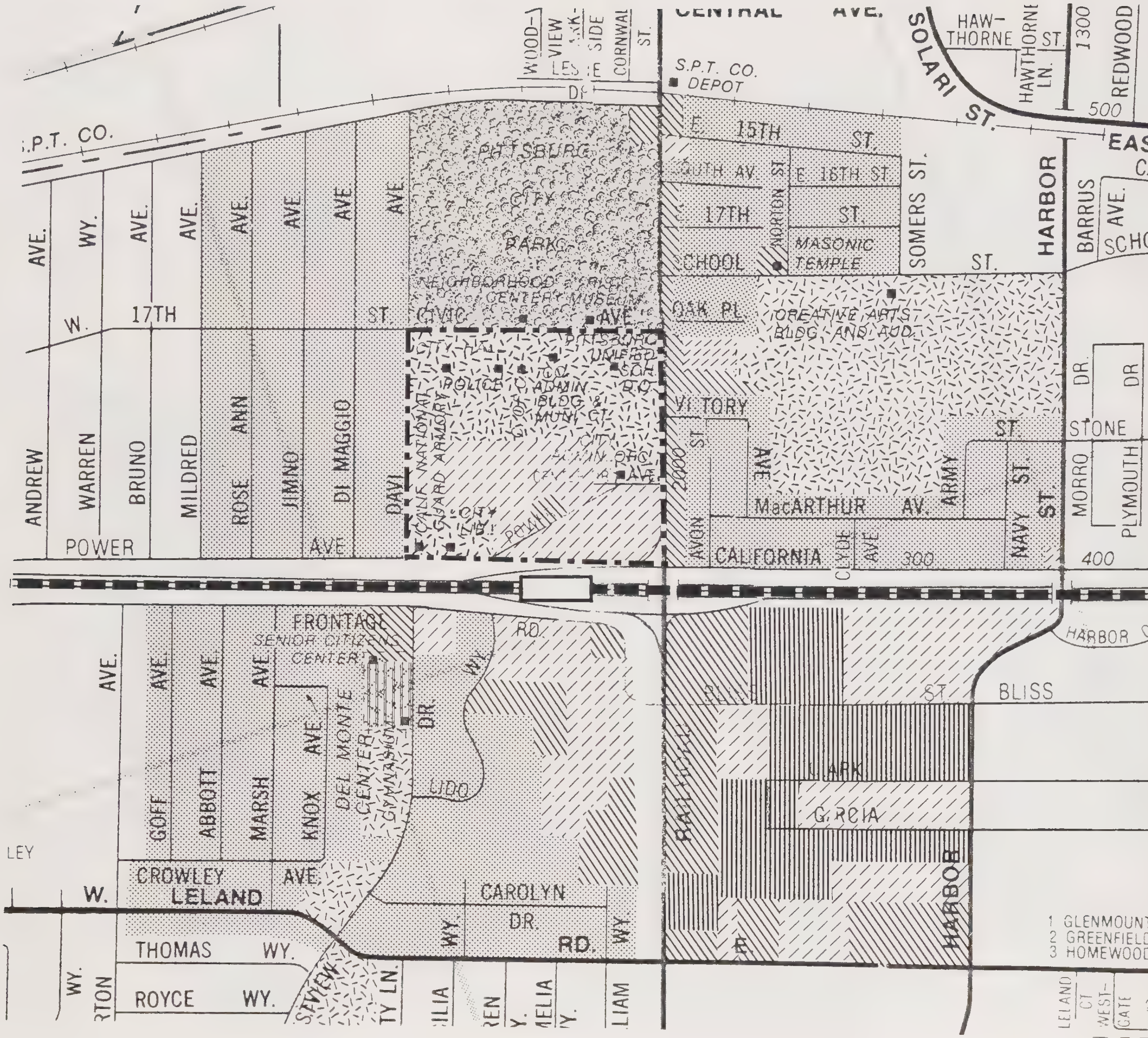
EXISTING LAND USES
STATION E
Pittsburg–Antioch Corridor AA/DEIR

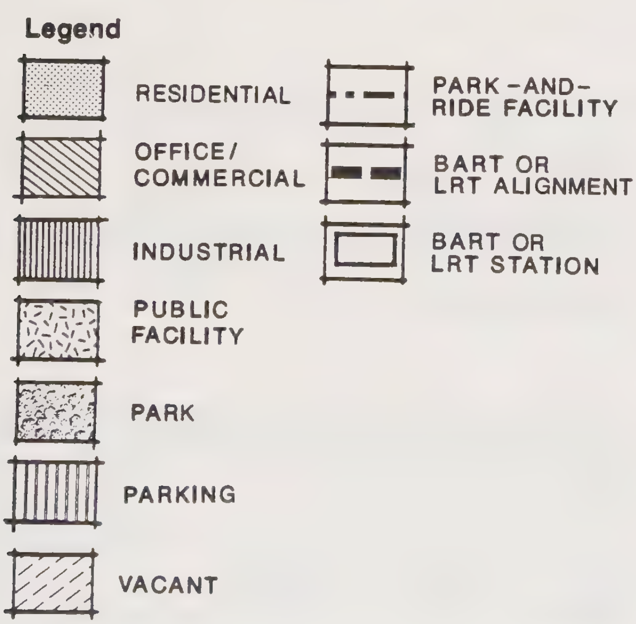
North

0 500 1000 FEET

BART

Exhibit A.5





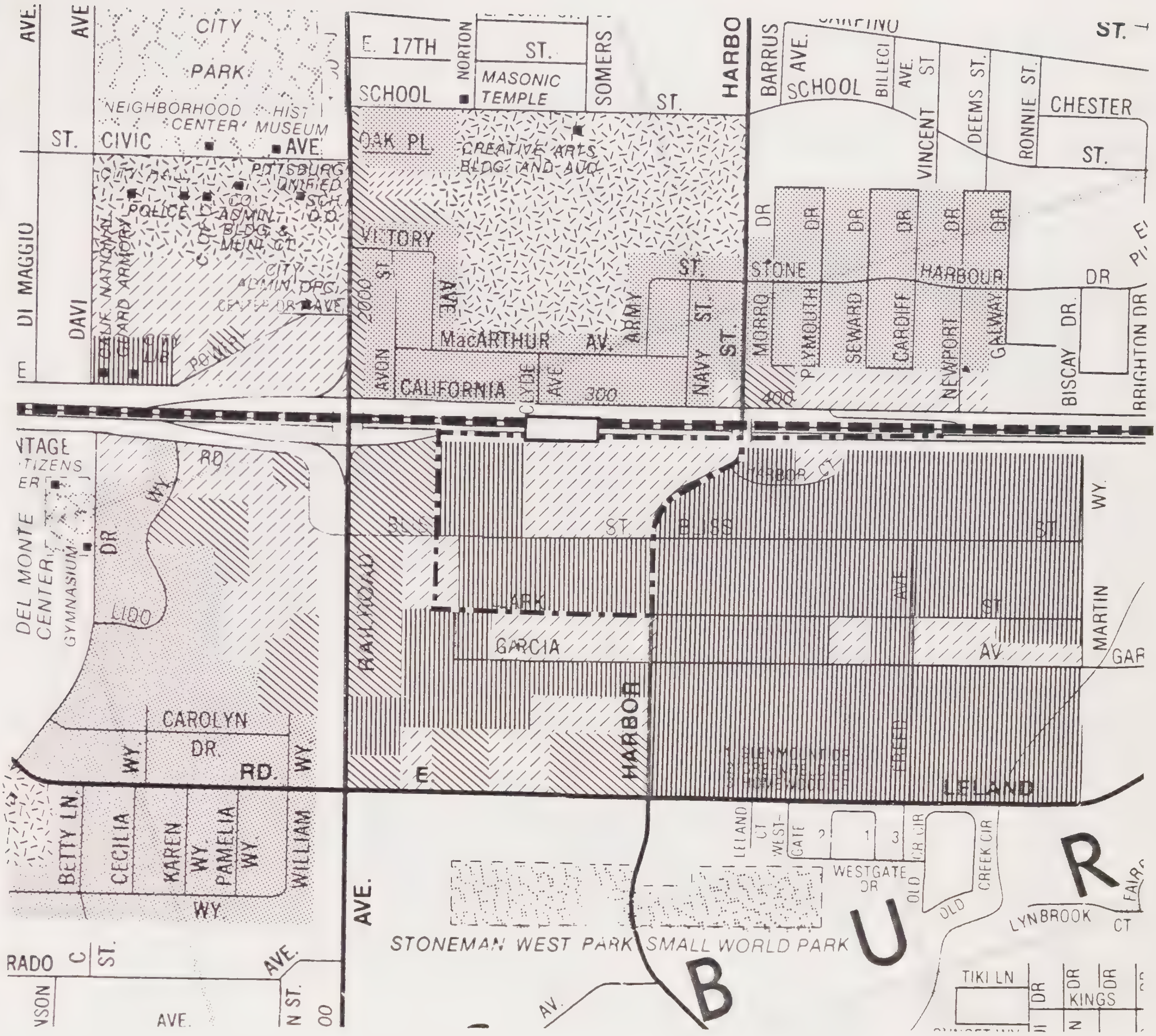
EXISTING LAND USES
STATION F

Pittsburg–Antioch Corridor AA/DEIR

North 0 500 1000FEET

BART

Exhibit A.6



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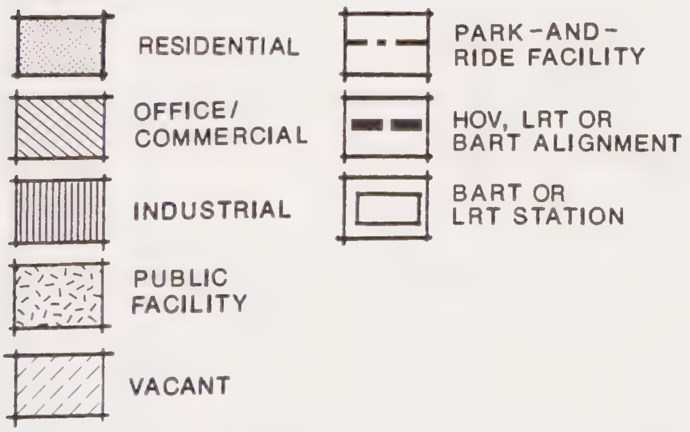
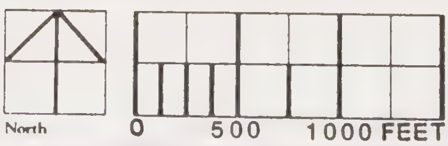


EXISTING LAND USES
STATION F(ALT)
Pittsburg-Antioch Corridor AA/DEIR



BART

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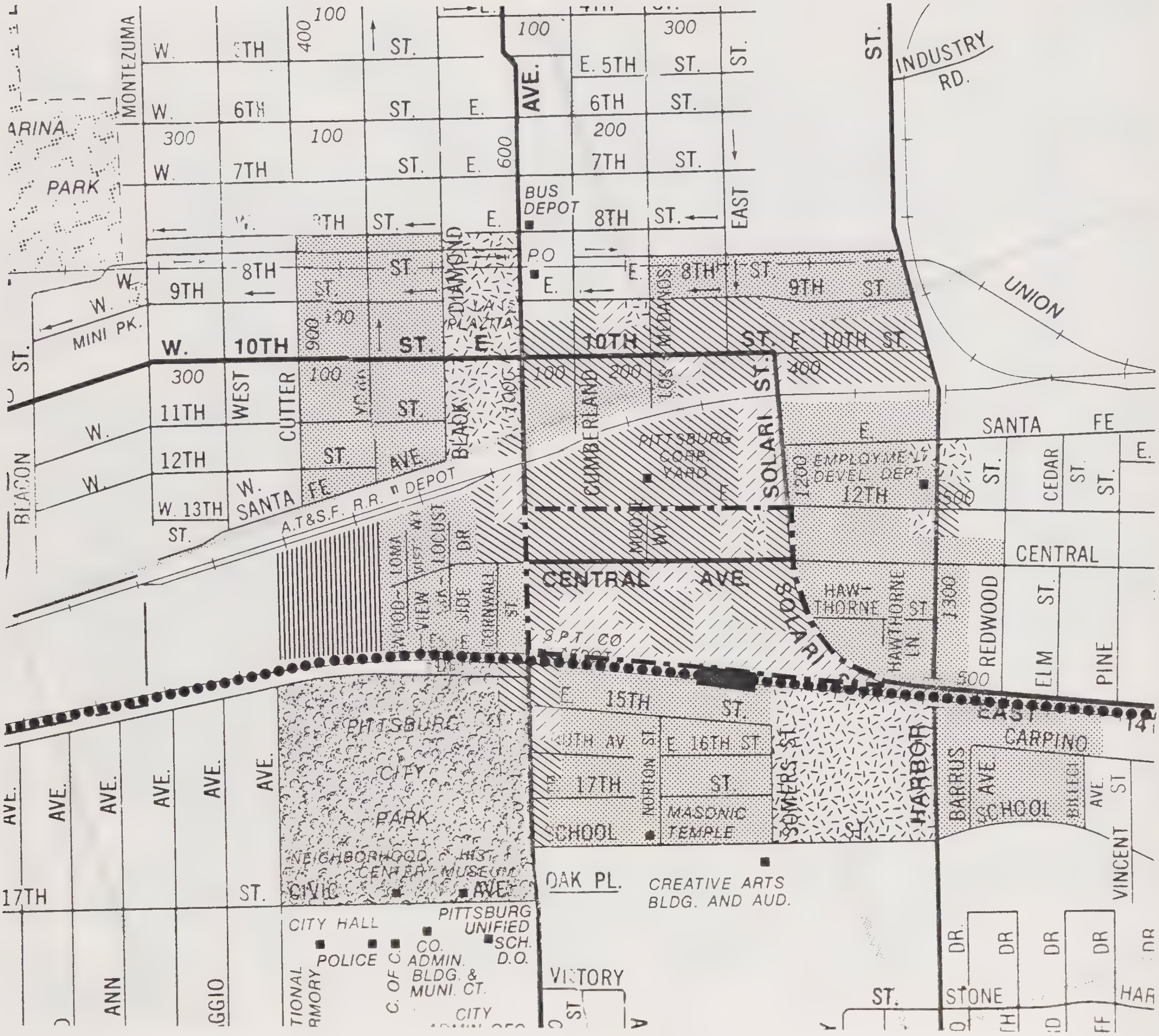
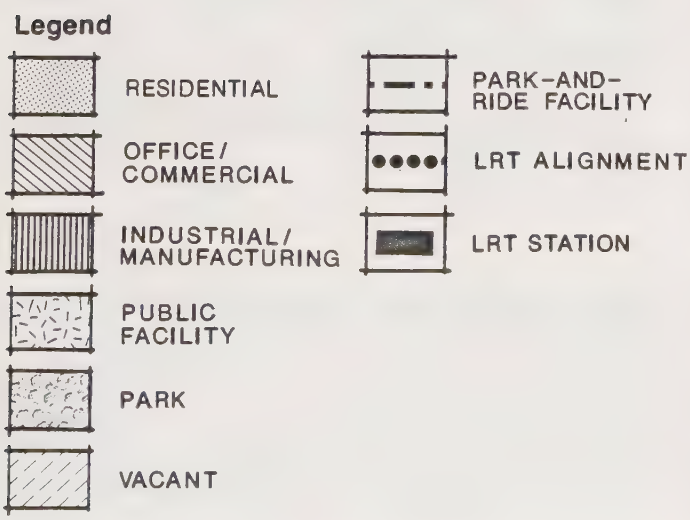
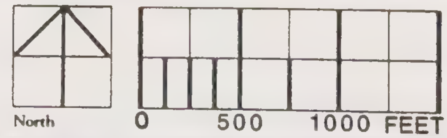




EXISTING LAND USES
STATION G
Pittsburg–Antioch Corridor AA/DEIR



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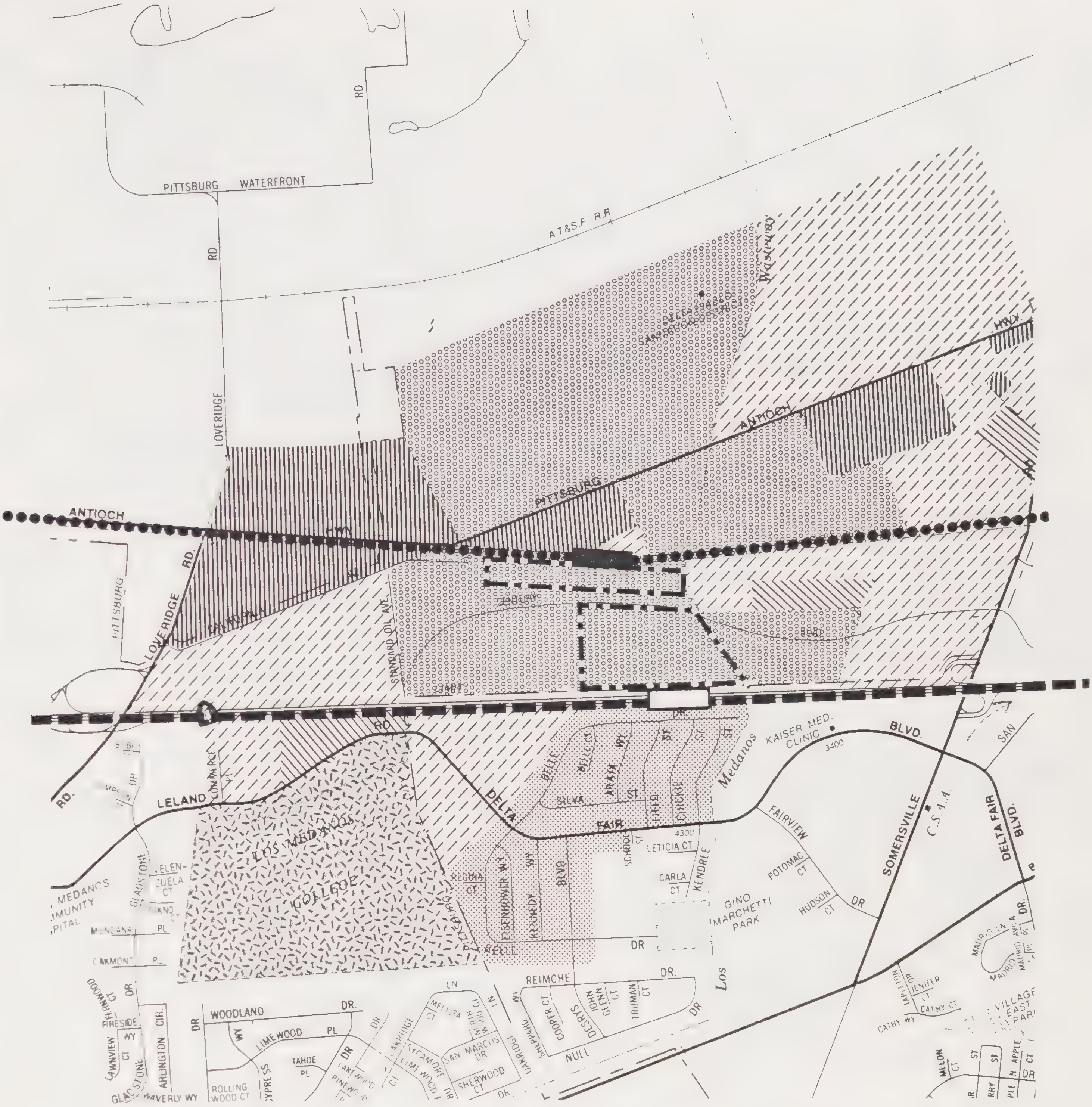


EXISTING LAND USES

STATIONS H & I

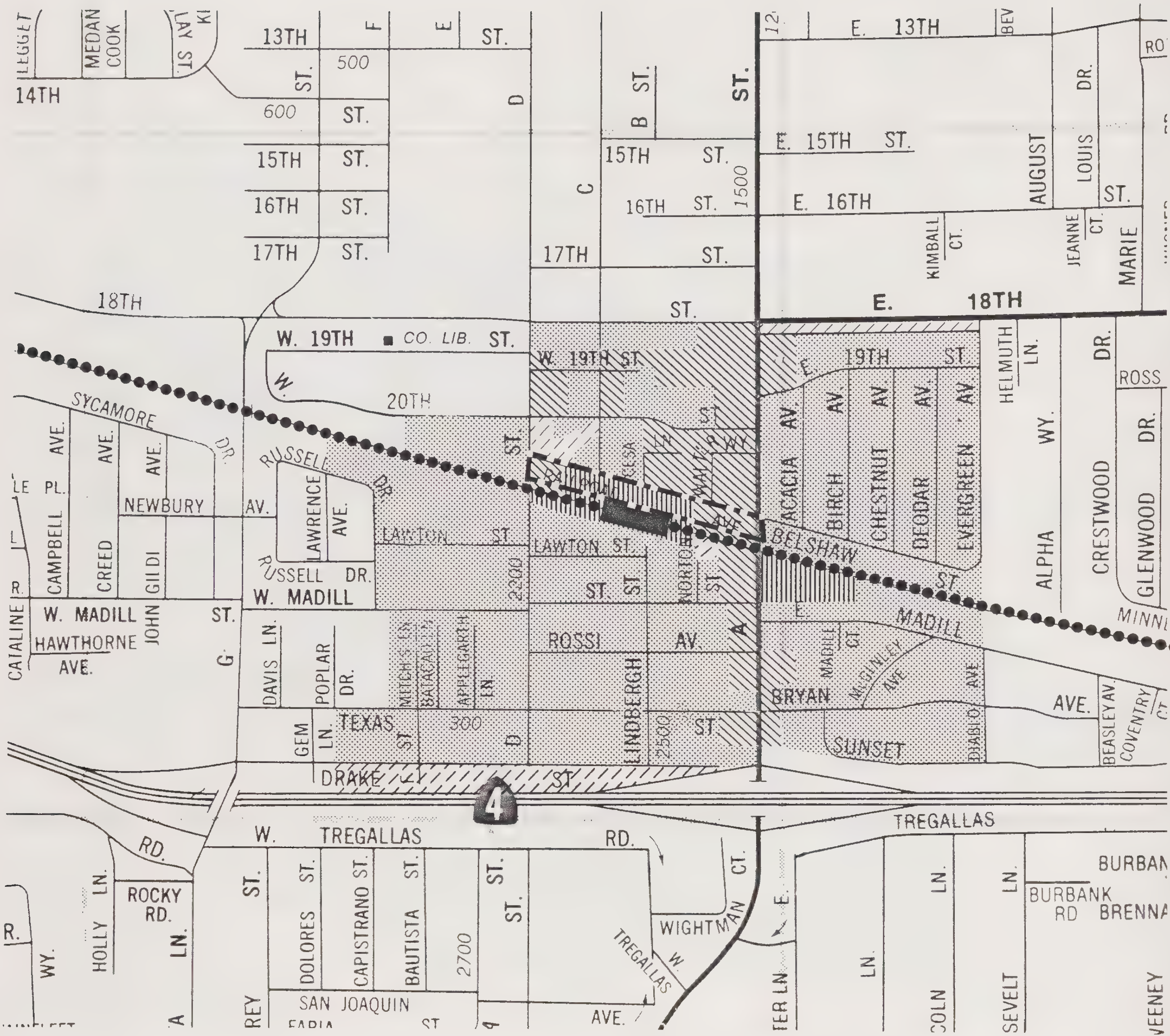
Pittsburg-Antioch Corridor AA/DEIR

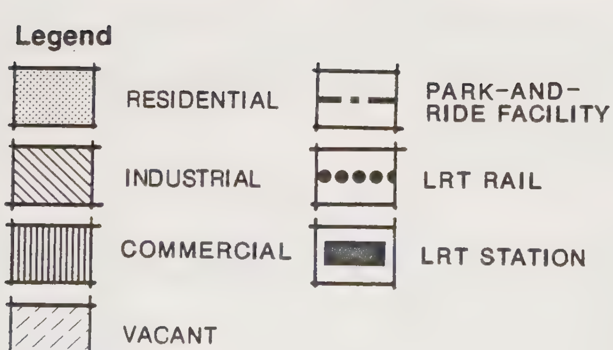
Legend

- RESIDENTIAL
- OFFICE/ COMMERCIAL
- INDUSTRIAL/ MANUFACTURING
- SCHOOL
- AGRICULTURE
- VACANT
- PARK-AND-RIDE FACILITY
- HOV, LRT OR BART ALIGNMENT
- LRT ALIGNMENT
- LRT OR BART STATION
- LRT STATION

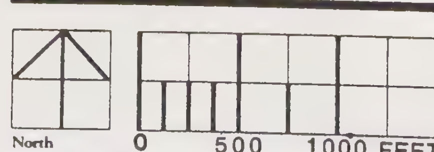
BART

Exhibit A.9





EXISTING LAND USES
STATION J
Pittsburg–Antioch Corridor AA/DEIR



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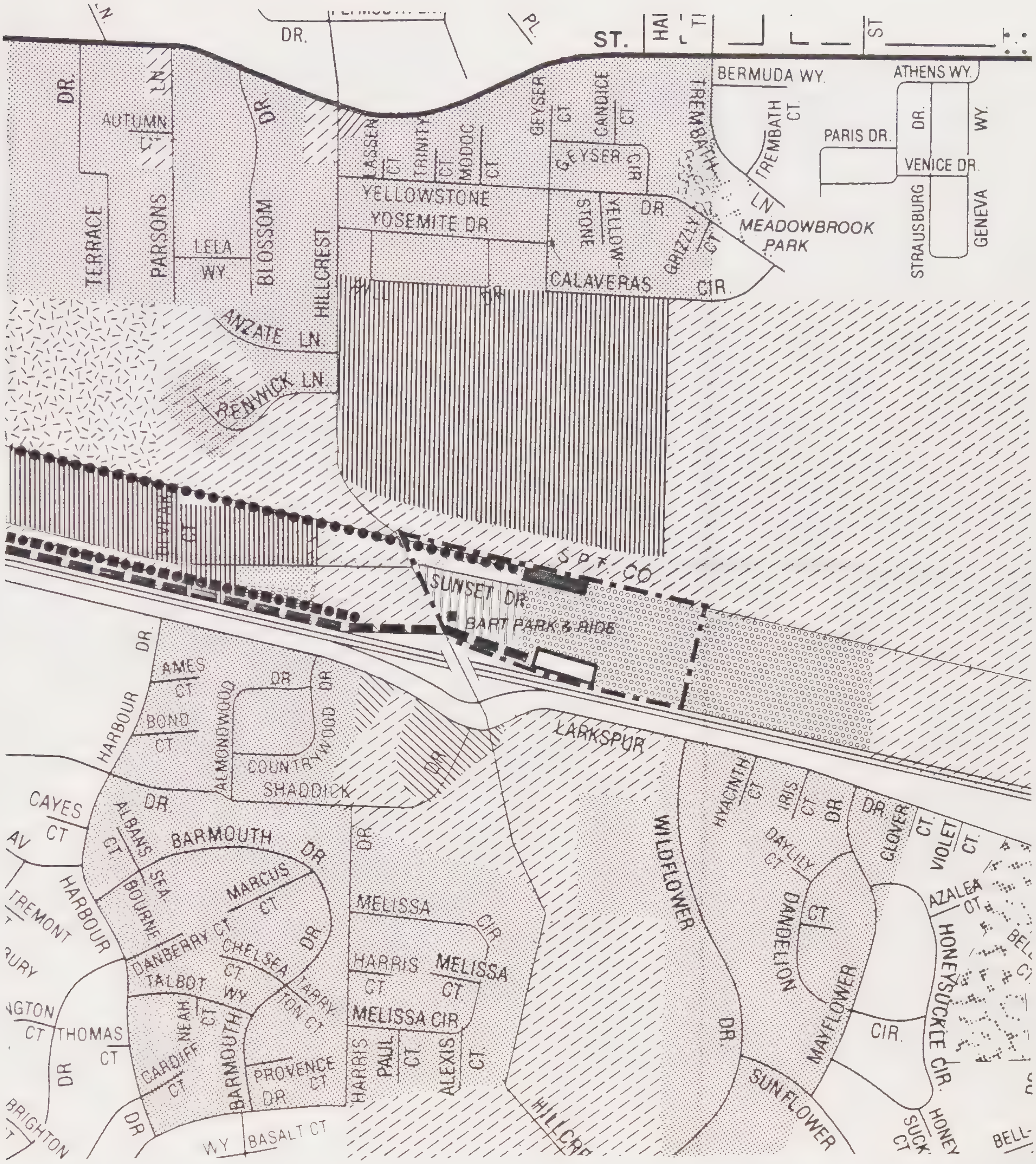


Legend

	RESIDENTIAL		PARK AND RIDE FACILITY
	COMMERCIAL/ OFFICE		LRT OR BART ALIGNMENT
	INDUSTRIAL		LRT ALIGNMENT
	SCHOOL		HOV, LRT OR BART ALIGNMENT
	AGRICULTURE		LRT OR BART STATION
	PARKING		LRT STATION
	VACANT		

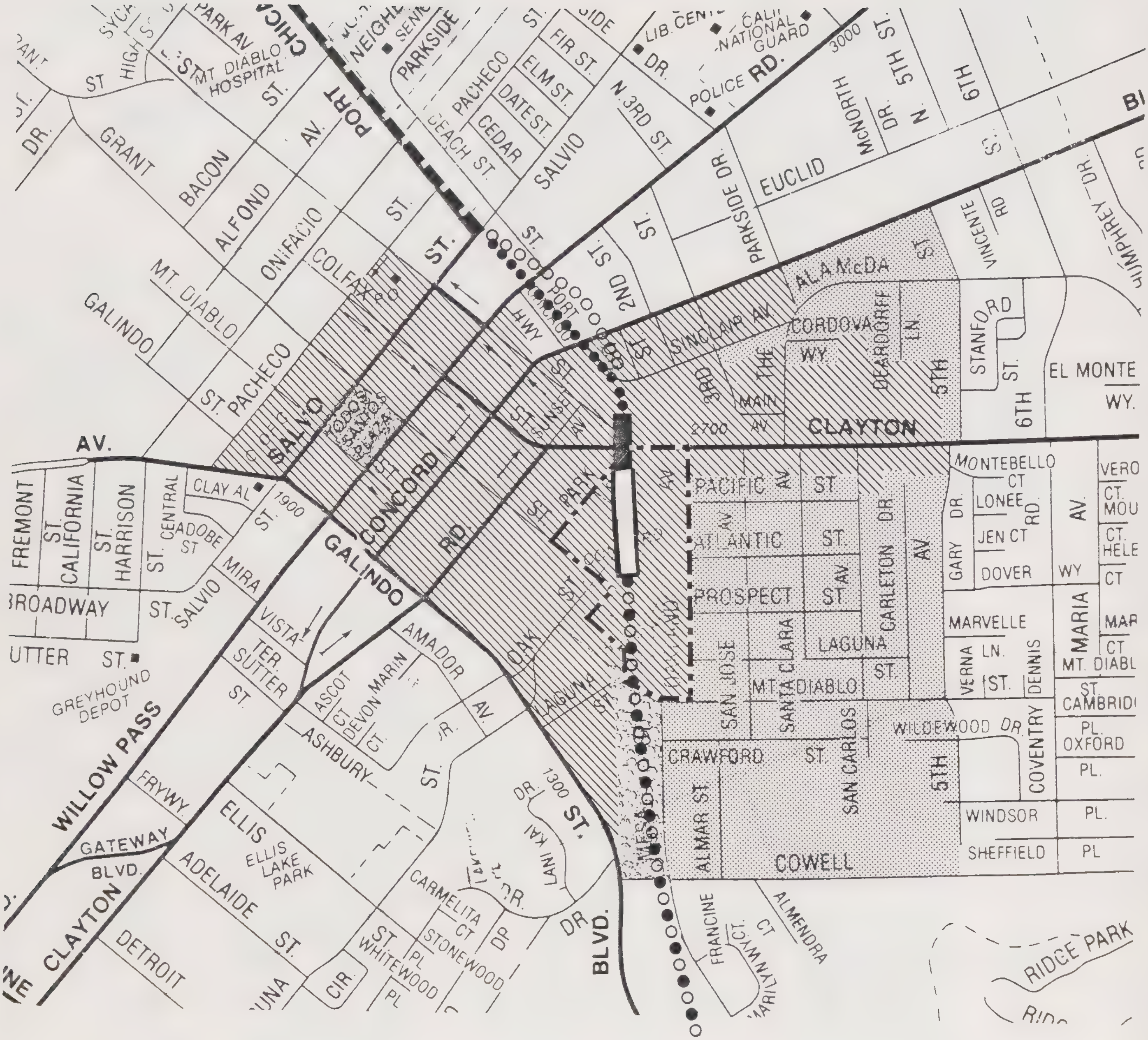
EXISTING LAND USES
STATION K
Pittsburg–Antioch Corridor
AA/DEIR

North

0 500 1000 FEET

BART

Exhibit A.11



Legend

- RESIDENTIAL
- OFFICE/ COMMERCIAL
- PARK
- PARK AND RIDE FACILITY
- LRT OR BART ALIGNMENT
- LRT ALIGNMENT
- BART ALIGNMENT
- EXISTING BART ALIGNMENT
- BART STATION
- LRT STATION

GENERAL PLAN DESIGNATIONS

STATION A

Pittsburg – Antioch Corridor

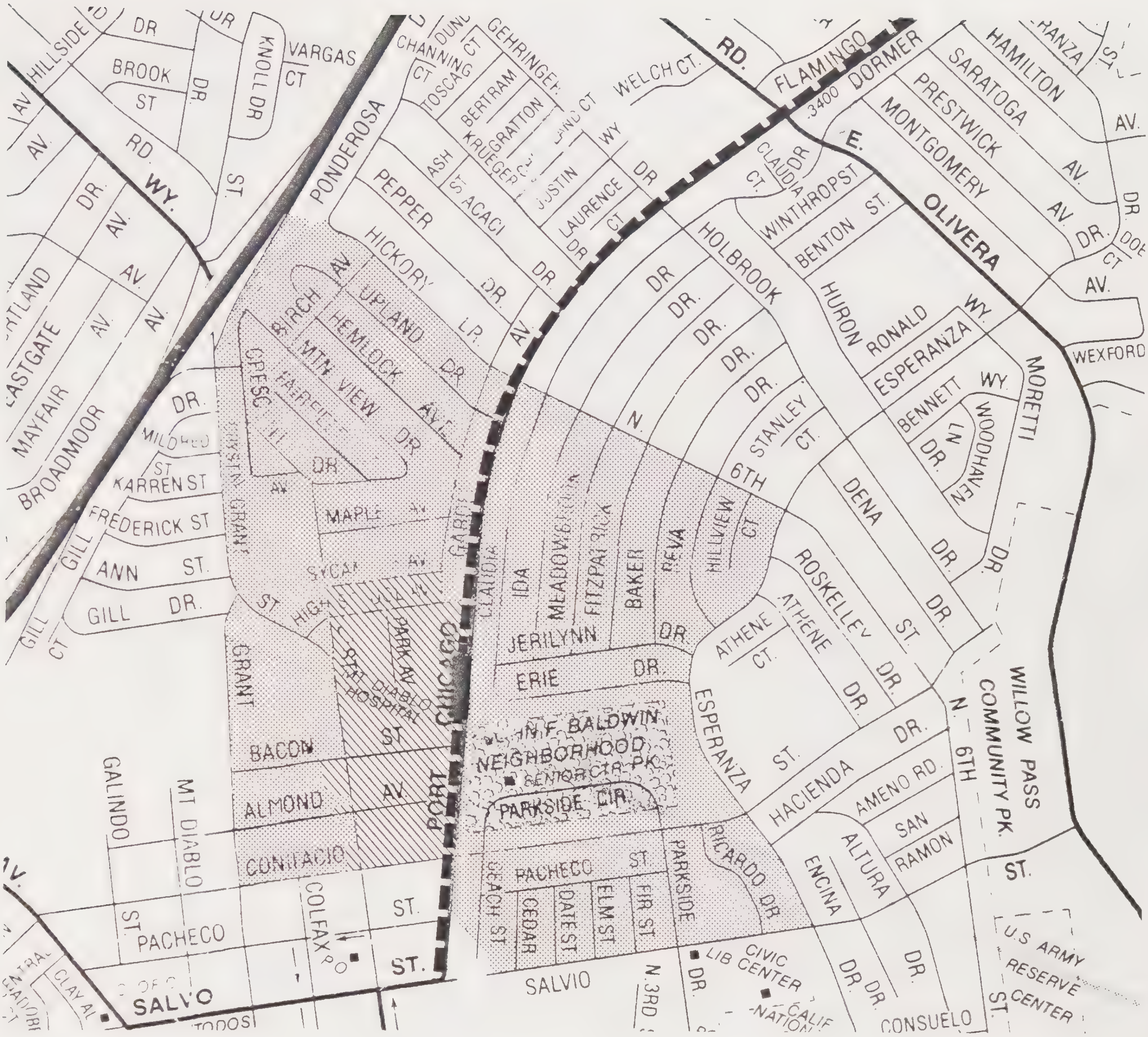
AA/DEIR

North

0 500 1000 FEET

BART

Exhibit A.12



Legend

RESIDENTIAL	LRT OR BART ALIGNMENT
OFFICE/COMMERCIAL	LRT STATION
PARK	

GENERAL PLAN DESIGNATIONS

STATION B

Pittsburg – Antioch Corridor AA/DEIR

North

0 500 1000 FEET

BART

Exhibit A.13

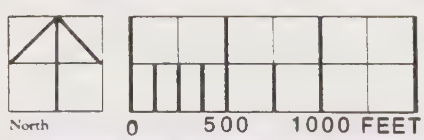
Legend

- RESIDENTIAL
- NAVAL WEAPONS STATION
- PARK AND RIDE FACILITY
- LRT OR BART ALIGNMENT
- LRT ALIGNMENT
- BART ALIGNMENT
- LRT OR BART STATION
- BART TURNBACK

GENERAL PLAN DESIGNATIONS

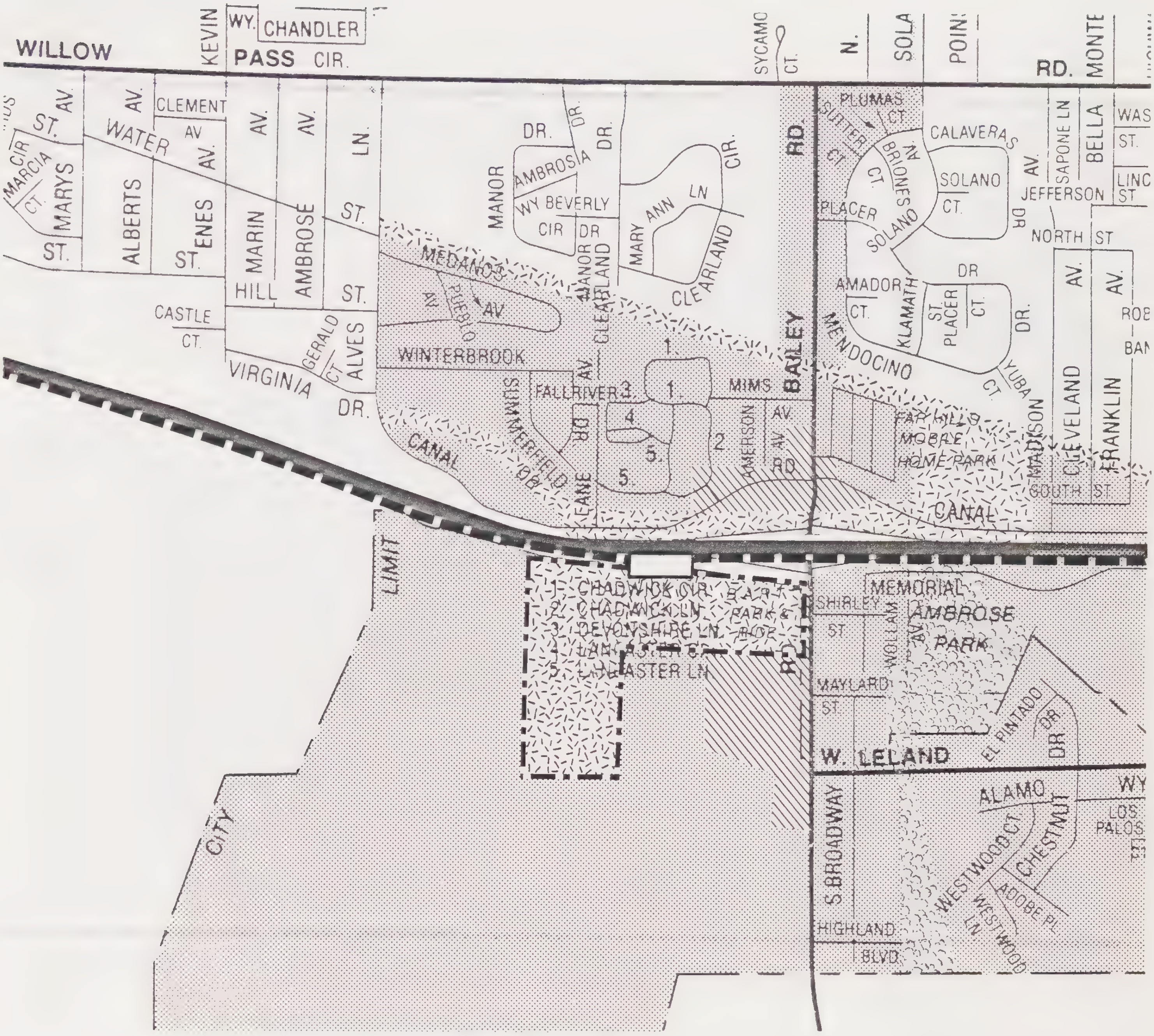
STATION C

Pittsburg –Antioch Corridor AA/DEIR



BART

Exhibit A.14



Legend

- RESIDENTIAL
- OFFICE/COMMERCIAL
- PUBLIC/SEMI-PUBLIC
- PARK
- PARK-AND-RIDE FACILITY
- HOV, LRT OR BART ALIGNMENT
- LRT OR BART STATION

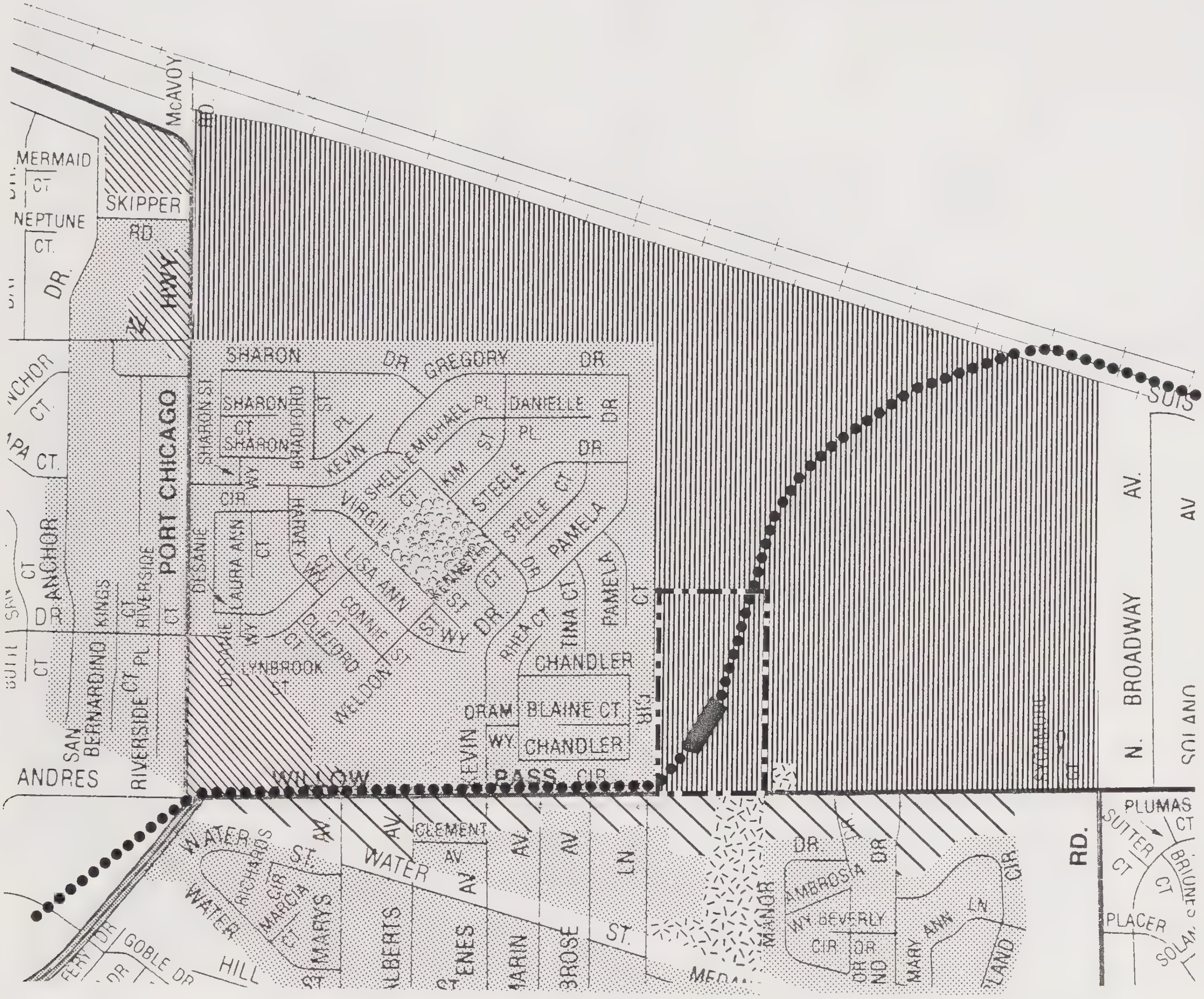
General Plan Designations
Station D
Pittsburg–Antioch Corridor
AA/DEIR

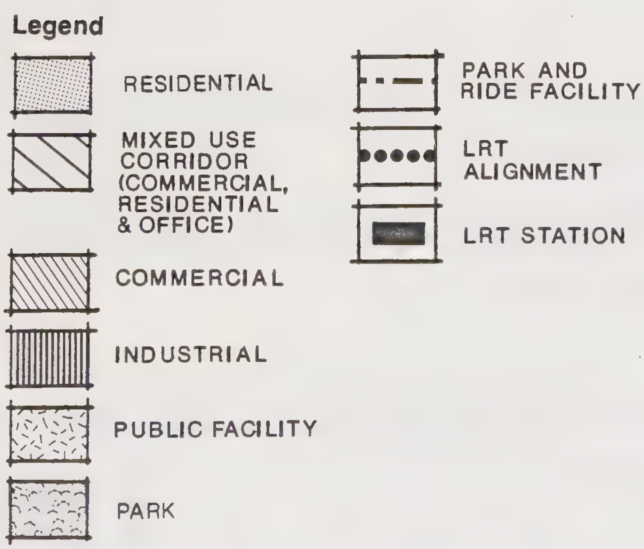
North

0 500 1000 FEET

BART

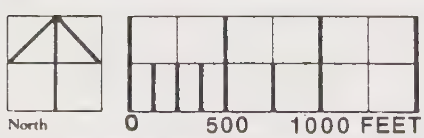
Exhibit A.15





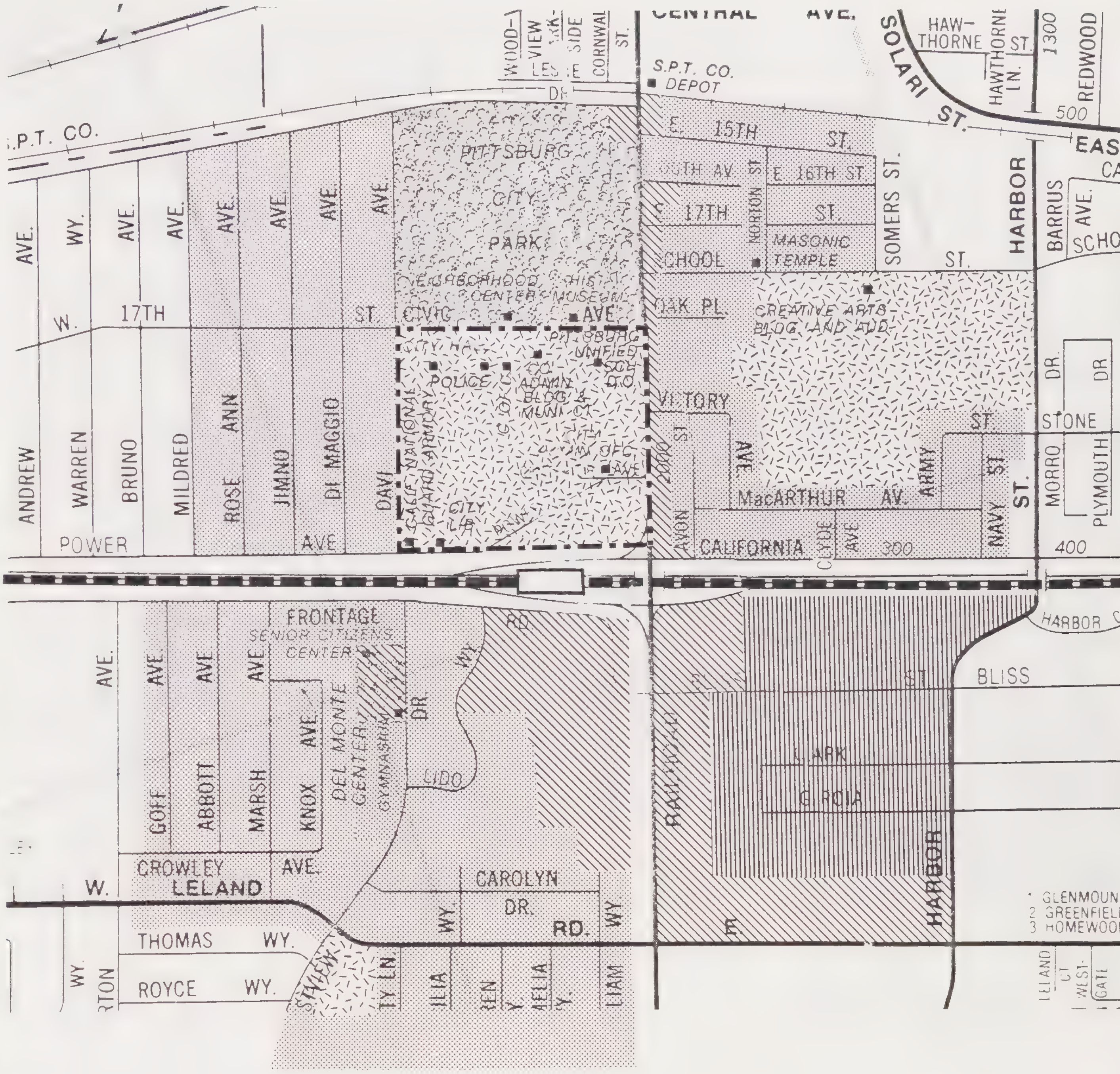
GENERAL PLAN DESIGNATIONS STATION E

Pittsburg–Antioch Corridor AA/DEIR



BART

Exhibit A.16



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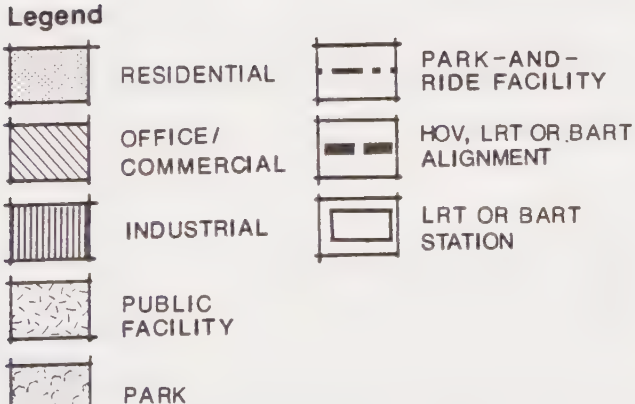
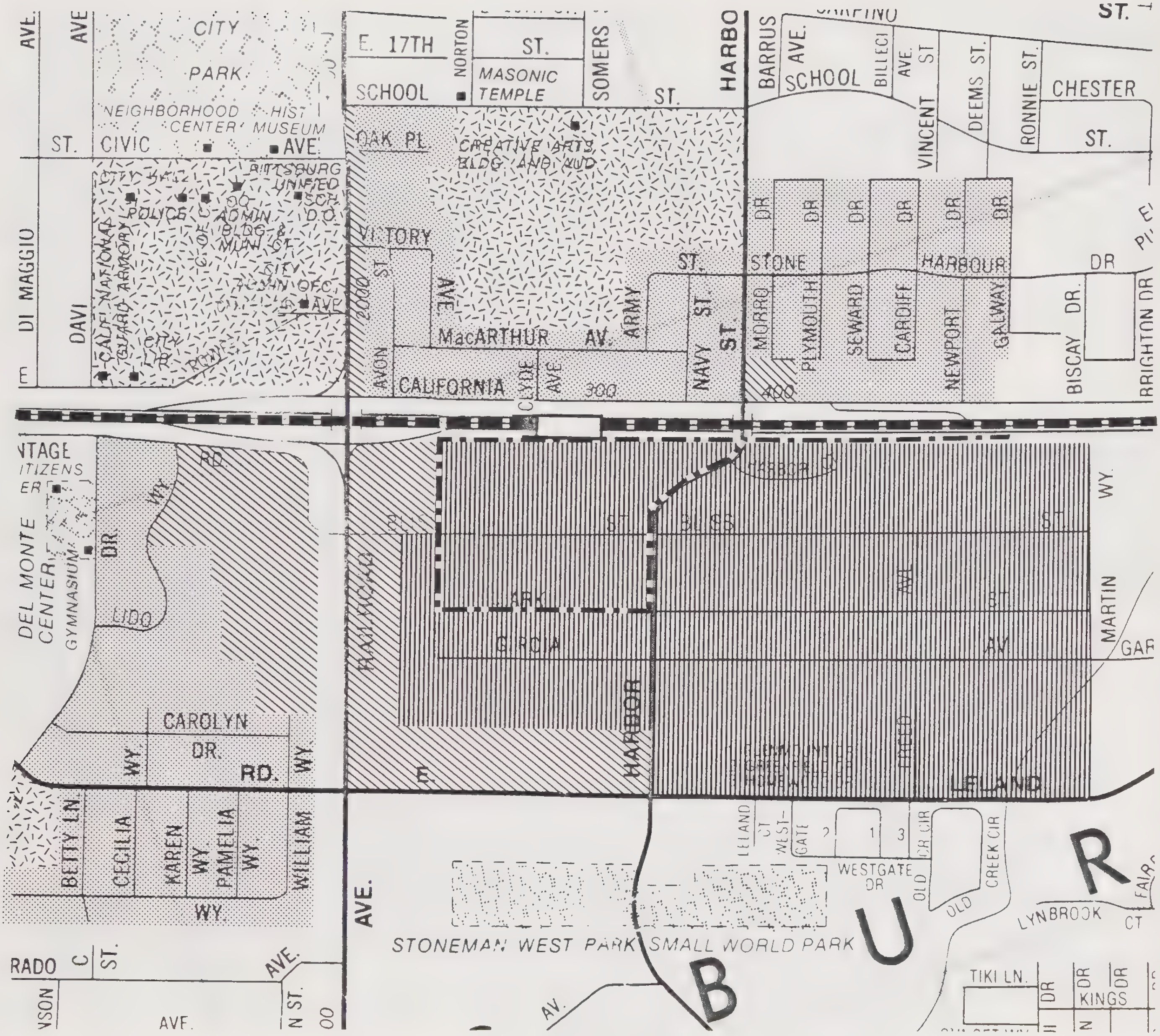


GENERAL PLAN DESIGNATIONS
STATION F
Pittsburg–Antioch Corridor
AA/DEIR

BART

Exhibit A.17



Legend

- RESIDENTIAL
- OFFICE COMMERCIAL
- INDUSTRIAL
- PUBLIC FACILITY
- PARK-AND-RIDE FACILITY
- HOV, LRT OR BART ALIGNMENT
- LRT OR BART STATION

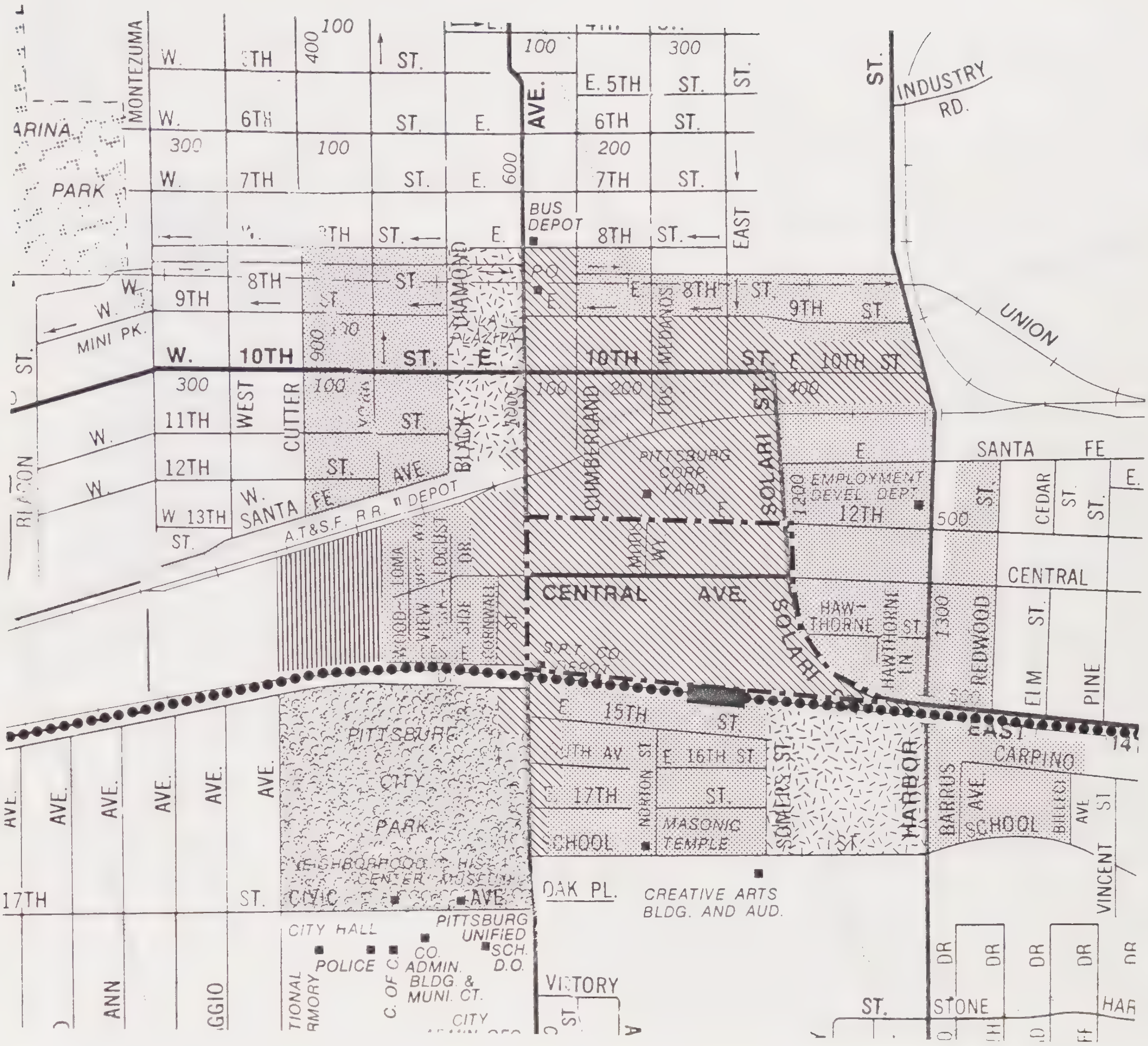
GENERAL PLAN DESIGNATIONS
STATION F(ALT)
Pittsburg-Antioch Corridor
AA/DEIR

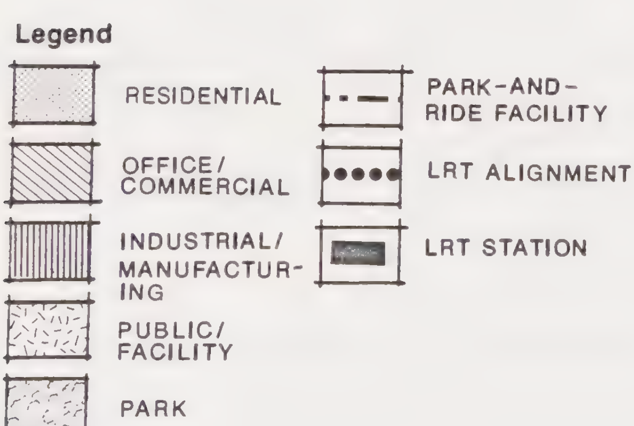
North

0 500 1000 FEET

BART

Exhibit A.18



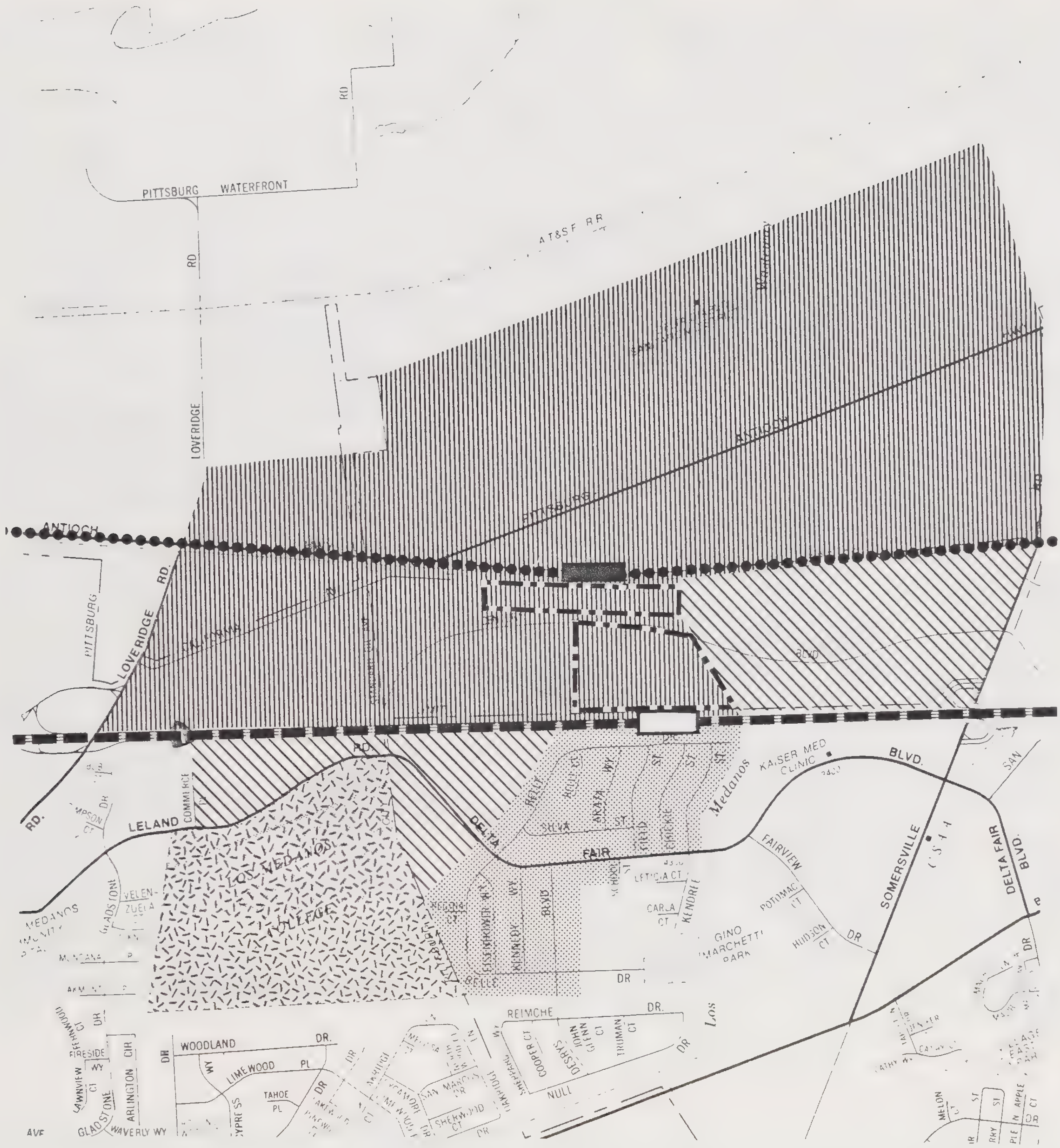


GENERAL PLAN DESIGNATIONS
STATION G

Pittsburg–Antioch Corridor
AA/DEIR

BART

Exhibit A.19



Legend

- RESIDENTIAL
- OFFICE / COMMERCIAL
- INDUSTRIAL / MANUFACTURING
- SCHOOL
- PARK AND RIDE FACILITY
- HOV, LRT OR BART ALIGNMENT
- LRT ALIGNMENT
- LRT OR BART STATION
- LRT STATION

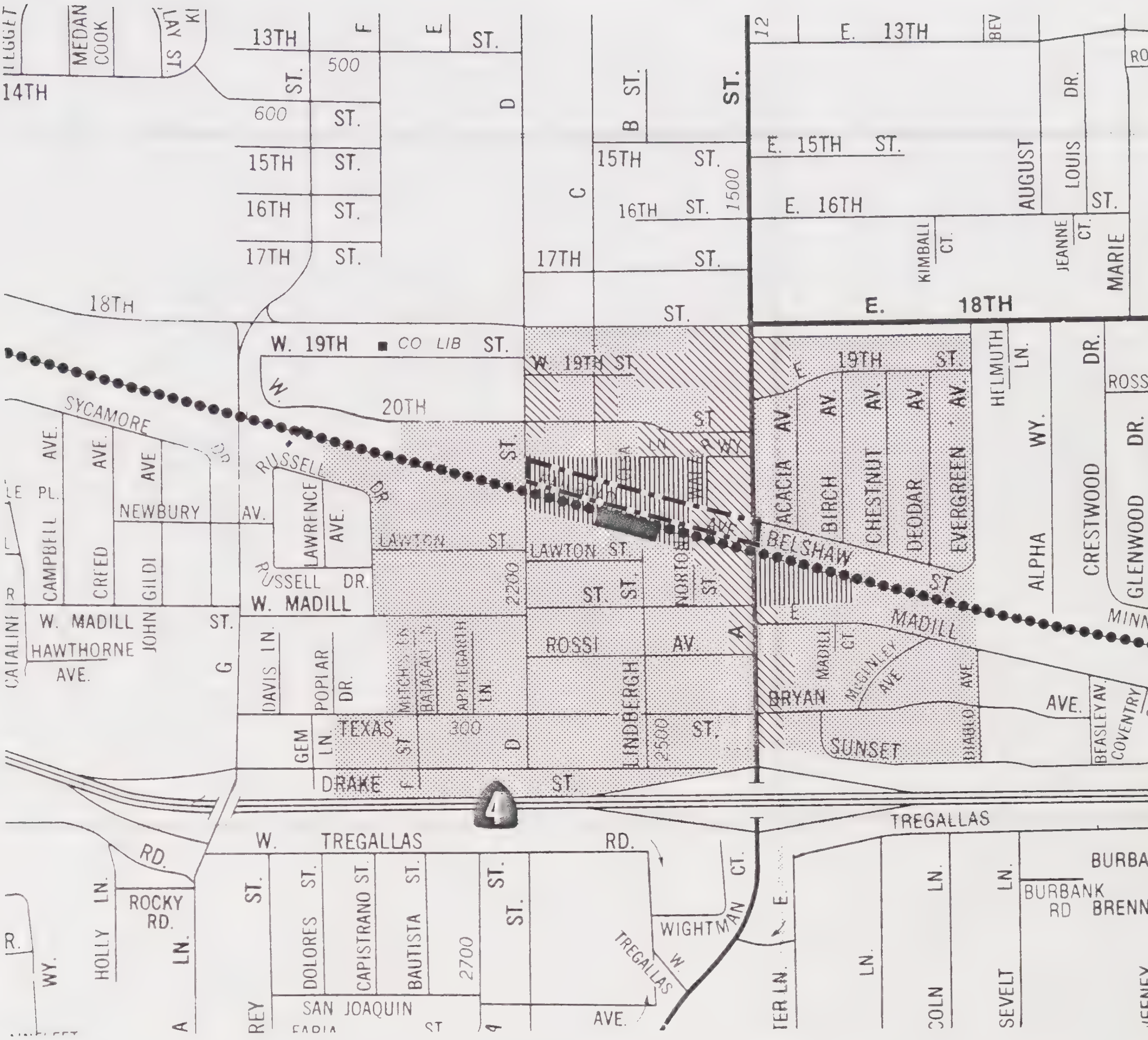
GENERAL PLAN DESIGNATION STATIONS H&I

Pittsburg–Antioch Corridor AA/DEIR

North 0 FEET

BART

Exhibit A.20



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- RESIDENTIAL
- OFFICE/ COMMERCIAL
- INDUSTRIAL
- PARK AND RIDE FACILITY
- LRT ALIGNMENT
- LRT STATION

GENERAL PLAN DESIGNATIONS STATION J

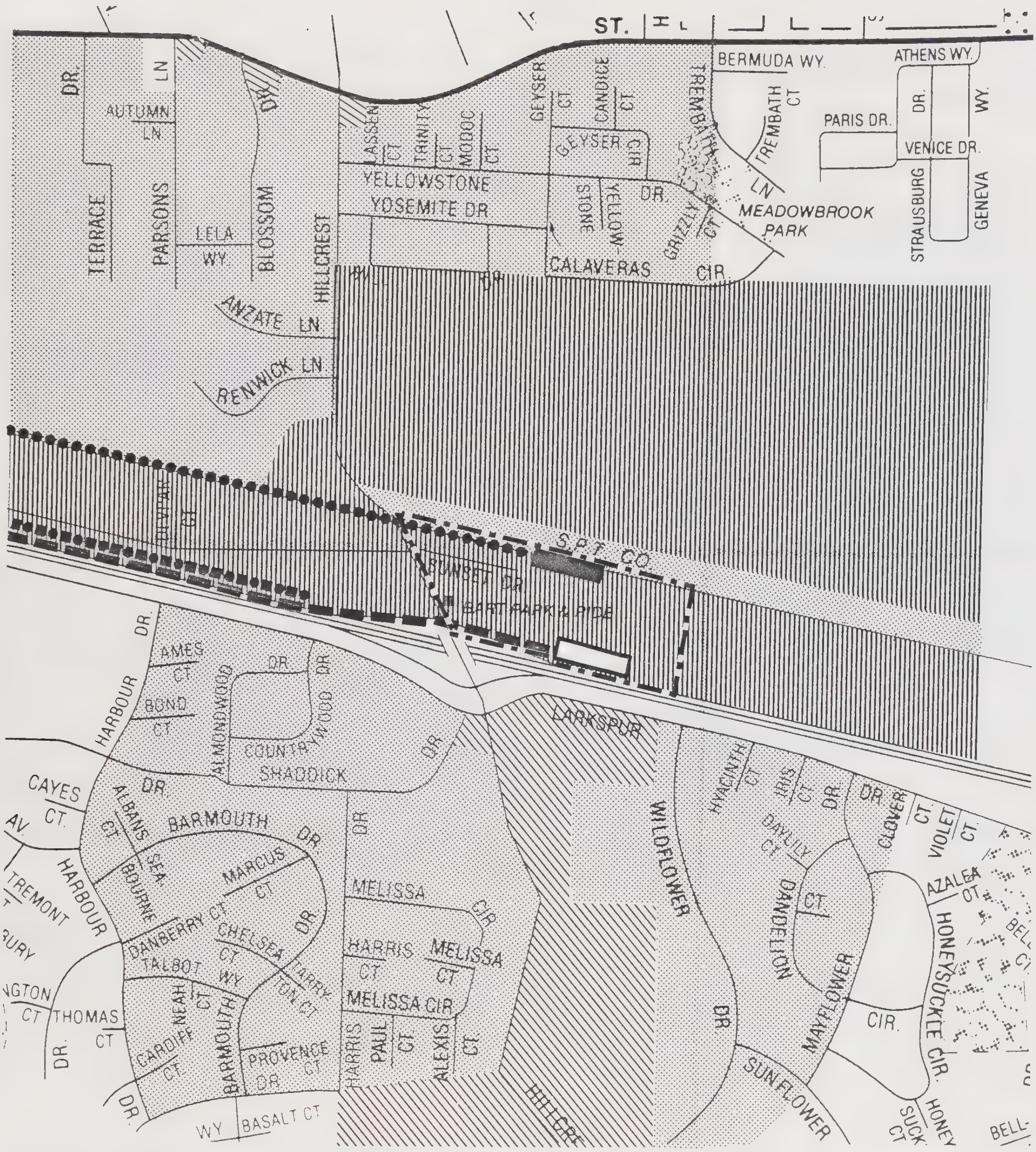
Pittsburg–Antioch Corridor AA/DEIR

North

0 500 1000 FEET

BART

Exhibit A.21



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RESIDENTIAL

COMMERCIAL/ OFFICE

INDUSTRIAL

PARK AND RIDE FACILITY

LRT OR BART ALIGNMENT

LRT ALIGNMENT

HOV, LRT OR BART ALIGNMENT

LRT OR BART STATION

LRT STATION

GENERAL PLAN DESIGNATIONS STATIONS K

Pittsburg-Antioch Corridor AA/DEIR

BART

Exhibit A.22

Appendix B
Economic Activity/Demographics

PITTSBURG-ANTIOCH CORRIDOR
ECONOMIC ACTIVITY AND DEMOGRAPHICS ANALYSIS

Prepared for:

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and
Bay Area Rapid Transit District
Oakland, California

Prepared by:

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1212 Broadway, Suite 1700
Oakland, California 94612

Contact: Marian F. Wolfe, Ph.D.

July 1988

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APPENDIX B

ECONOMIC ACTIVITY/DEMOGRAPHICS

B.1 AFFECTED ENVIRONMENT

B.1.1 REGIONAL TRENDS

Contra Costa County is presently one of the fastest growing counties in the San Francisco Bay Area. Over the past thirty years, a combination of growth in office and service related employment has transformed the county into a major regional employment center. Contra Costa County is projected to continue this high growth over the next few decades. It is then anticipated that the rate of growth will slow as the supply of land considered appropriate for development diminishes.

Population

Contra Costa County's population increased by 17.5 percent between 1970 and 1980, and by 1987 the population is estimated to have increased by another 11.9 percent for a total of 734,450. (See Table B.1.) Household growth exceeded population growth during this period.

Although the percentage of the population over age 65 in 1980 (9.3 percent) was slightly lower than the percentage for the State of California (10.2 percent), the population is aging at a faster rate and the percentage of the population under 15 years of age is declining faster in Contra Costa County than for the State of California. These figures indicate a "graying" of the population in Contra Costa County (Contra Costa County, 1985).

The racial composition of the county has changed as the population increased. Whereas before World War II, less than five percent of the population was comprised of nonwhites, by 1980, almost twenty percent of the population was nonwhite, and approximately eight percent was Hispanic. Racial composition varies by subarea. East county has the highest percentage and greatest number of Hispanic residents than either the west or central county areas. West county has the highest percentage of black residents. (Contra Costa County, 1985.)

Although median and mean nominal family income more than doubled between 1970 and 1980, in constant dollars there was little change during the decade. Average income for 1980 in Contra Costa County ($29,885) was slightly higher than in the San Francisco Bay Area as a whole ($28,185).

Most households have access toautomobiles. In 1980, only 6.5 percent of households had no vehicle at their residences and almost sixty percent of households had two or more vehicles. This high degree of auto accessibility is typical of middle income, suburban communities.

	Contra Costa County				City of Antioch				Brentwood Area (Census Tracts 3031 & 3032)			
	1970	1980	% Change 1970-1980[1]	1987 Estimate	1970	1980	% Change 1970-1980[1]	1987 Estimate	1970	1980	% Change 1970-1980[1]	1987 Estimate
Total Population	558,389	656,380	17.5%	734,450[2]	28,060	42,683	52.1%	51,789[2]	5,632	8,134	44.4%	NA
Number of Households	173,951	241,534	39.7%		8,593	14,955	74.0%		1,661	2,637	58.8%	
Income of all Families												
Mean	$13,778	$29,885	1.6%		$11,679	$23,902	-4.2%		$10,344	$25,096	13.6%	
Median	$12,423	$26,510	-0.1%		$10,972	$22,904	-2.2%		NA	NA		

	Clyde Area (Census Track 3150p)				City of Concord				City of Martinez			
	1970	1980	% Change 1970-1980[1]	1987 Estimate	1970	1980	% Change 1970-1980[1]	1987 Estimate	1970	1980	% Change 1970-1980[1]	1987 Estimate
Total Population	529	404	-23.6%	NA	85,164	103,255	21.2%	108,009[2]	16,506	22,582	36.8%	28,783[2]
Number of Households	179	160	-16.5%		24,574	38,152	55.3%		5,309	8,406	58.3%	
Income of all Families												
Mean	$11,593	$20,685	-16.5%		$12,690	$26,844	-0.1%		$12,484	$28,793	8.0%	
Median	$11,071	$21,250	-10.1%		$12,614	$25,648	-4.8%		12,014	$27,310	6.4%	

	Oakley Area (Census Track 3020)				City of Pittsburg				West Pittsburg Area[3]			
	1970	1980	% Change 1970-1980[1]	1987 Estimate	1970	1980	% Change 1970-1980[1]	1987 Estimate	1970	1980	% Change 1970-1980[1]	1987 Estimate
Total Population	4,670	7,098	52.0%	NA	20,651	33,034	60.0%	41,623[2]	10,007	10,295	2.9%	NA
Number of Households	1,411	2,508	77.7%		6,445	11,087	72.0%		3,213	3,996	24.4%	
Income of all Families												
Mean	$9,210	$23,247	18.2%		$9,633	$22,416	9.0%		$8,682	$16,350	-11.9%	
Median	$8,922	$21,153	11.0%		$9,224	$21,684	10.1%		NA	NA	NA	

[1] Although dollar amounts presented in this table are unadjusted, for purposes of calculating a percentage change between 1870 and 1980, dollar amounts have been adjusted to the base year of 1967 using the CPI for all items (San Francisco-Oakland SMSA: 1970 = 1.158 and 1980 = 2.473).

[2] 1987 Department of Finance estimates.

[3] West Pittsburg Area comprised of Census Tracts 3141 and 3142. Tract 3090P is included in 1980 to compensate for a Census Bureau error. Part of Tract 3141 was annexed to Pittsburg in the 1980 Census and is not included in that year's West Pittsburg totals.

SOURCE: With the exception of a few characteristics noted above, the source for the table is U.S. Department of Commerce, 1970 and 1980.

TABLE B.1

POPULATION CHARACTERISTICS
CONTRA COSTA COUNTY STUDY, AREA CITIES AND UNINCORPORATED AREAS

Housing Characteristics

Growth in housing units over the period 1970-1980 was approximately forty percent. This increase closely parallels the growth in households during the same period and is more than double the rate of increase in population (See Table B.2). Although the housing stock has continued to grow, the annual county growth rate was lower between 1980 and 1987 than it was in the previous decade. About one-third of all housing units in 1980 were ten years old or less. The relative newness of the housing stock reflects the rapid rate of housing construction in the 1970's.

In 1985 the vacancy rate was two percent. (See Table B.2.) Although the vacancy rate is below that considered necessary for household mobility (four to six percent), it is typical of the low vacancy rate in the San Francisco Bay Area.

Approximately two-thirds of Contra Costa County's housing is owner-occupied, and this rate has remained stable. Eighty-four percent of all housing units were in structures with four units or less in 1980. This proportion is down slightly from 1970, when eighty-eight percent of units were in structures with four units or less. In other words, there was a faster rate of construction of multifamily structures than of smaller structures during that period (see Table B.2).

The median value of owner-occupied housing in constant dollars increased at about the same rate (seventy percent) as did housing prices statewide from 1970 to 1980. The phenomenon of faster growth in house prices than in incomes was typical during this period nationally and certainly more extreme in the San Francisco Bay Area. In 1985, the Contra Costa County Community Development Department estimated that in order to purchase a home at the average sales price of $154,000, a family would need to earn between $46,980 and $53,400 annually. Assuming 1980 median income increased with the rate of inflation and that there was no equity available from the sale of a previously owned home, the typical family in Contra Costa County earning $40,256 would not be able to afford the average priced house in Contra Costa County in 1985. However, it should be noted that buyers who were "moving up" in their housing consumption could afford more expensive housing than first time buyers. Also, there is a wide variation in the average sales price of housing from a high of $398,000 in the exclusive area of Blackhawk down to a low of $81,000 in the City of Pittsburg. (Contra Costa County, 1985.)

Employment Trends

The San Francisco Bay Area economy has undergone major structural changes in the last decade which have affected Contra Costa County. The Bay Area has experienced a growth in service and finance, insurance, and real estate (FIRE) sector employment over this period. There has also been a simultaneous decline in basic manufacturing employment (such as the steel industry) accompanied by growth in high technology and information based manufacturing industries. All these trends can be seen in Contra Costa County as well. Since 1980, twenty-two plant closures have resulted in the loss of 2,400 jobs in the manufacturing sector. This occurred while employment grew in the trade, FIRE, and services sectors by a total of 32,500 jobs. (See Table B.3.)

	Contra Costa County				City of Antioch				Brentwood Area (Census Tracts 3031 & 3032)			
	1970	1980	% Change 1970-1980[1]	Current Data	1970	1980	% Change 1970-1980[1]	Current Data	1970	1980	% Change 1970-1980[1]	Current Data
Total Number of Year-Round Units	178,312	251,721	4.2%	286,489[2]	8,855	15,660	76.8%	19,378[2]	1,727	2,780	61.0%	NA
Percentage Owner-Occupied	69.4%	68.3%			67.8%	66.4%			59.0%	63.9%		
Median Value of Owner-Occupied Units	$25,700	$94,300	71.8%		$20,100	$73,300	70.8%		NA	NA	NA	
Median Contract Rent	$124	$266	0.9%		$100	$237	11.6%		NA	NA	NA	
Units in Structure												
1-4[3]	157,782	212,186	34.5%		7,884	13,354	69.4%		1,676	2,494	48.8%	
5-49	17,323	28,829	66.4%		749	1,416	89.1%		74	254	243.2%	
50+	3,224	10,766	233.9%		178	882	395.5%		0	49	--	
Percentage of Units 10 Years Old or Less	36.6%	31.0%			39.0%	43.9%			25.4%	33.1%		
Housing Vacancy Rates				2.1%[4]				1.3%[4]				NA

TABLE B.2

HOUSING CHARACTERISTICS
CONTRA COSTA COUNTY, STUDY AREA CITIES AND UNINCORPORATED AREAS
(Continued on next page)

	Clyde Area (Census Track 3150p)				City of Concord				City of Martinez			
	1970	1980	% Change 1970-1980[1]	Current Data	1970	1980	% Change 1970-1980[1]	Current Data	1970	1980	% Change 1970-1980[1]	Current Data
Total Number of Year-Round Units	187	169	-9.6%	NA	25,471	39,488	55.0%		5,470	8,844	61.7%	11,703[2]
Percentage Owner-Occupied	73.3%	76.5%			69.5%	61.7%			60.7%	66.9%		
Median Value of Owner-Occupied Units	$17,700	$62,500	65.3%		$26,300	$90,900	61.8%		$24,500	$96,800	85.0%	
Median Contract Rent	$86	$250	36.1%		$153	$287	-12.1%		$92	$244	25.3%	
Units in Structure												
1-4[3]	170	158	-7.1%		21,488	29,896	39.1%		NA	7,984	NA	
5-49	4	14	250.0%		2,955	6,219	110.5%		NA	632	NA	
50+	0	0	--		1,004	3,375	236.2%		NA	228	NA	
Percentage of Units 10 Years Old or Less	16.1%	0.0%			52.4%	33.6%			NA	37.1%		
Housing Vacancy Rates				NA				1.4%[4]				2.6%[4]

TABLE B.2

HOUSING CHARACTERISTICS
CONTRA COSTA COUNTY, STUDY AREA CITIES AND UNINCORPORATED AREAS
(Continued on next page)

	Oakley Area (Census Track 3020)				City of Pittsburg				West Pittsburg Area[5]			
	1970	1980	% Change 1970-1980[1]	Current Data	1970	1980	% Change 1970-1980[1]	Current Data	1970	1980	% Change 1970-1980[1]	Current Data
Total Number of Year-Round Units	1,466	2,621	78.8%	NA	6,720	11,926	77.5%	14,745[2]	3,360	4,188	24.6%	NA
Percentage Owner-Occupied	60.0%	74.2%			60.2%	70.1%			63.9%	62.2%		
Median Value of Owner-Occupied Units	$17,300	$74,500	101.6%		$17,300	$68,400	85.1%		NA	NA	NA	
Median Contract Rent	$66	$153	8.6%		$75	$179	11.8%		NA	NA	NA	
Units in Structure												
1-4[3]	1,494	2,512	68.1%		NA	10,994	NA		3,143	3,854	226	
5-49	34	105	208.8%		NA	679	NA		182	359	97.3%	
50+	0	14	--		NA	254	NA		32	5	-84.4%	
Percentage of Units 10 Years Old or Less	25.1%	44.0%			NA	45.3%			27.4	19.7%		
Housing Vacancy Rates				NA				$4.4%[4]				NA[4]

[1] Although dollar amounts presented in this table are unadjusted, for purposes of calculating a percentage change between 1970 and 1980, dollar amounts have been adjusted to the base year of 1967 using the CPI for all items (San Francisco-Oakland SMSA: 1970 = 1.158 and 1980 = 2,473).

[2] 1987 Department of Finance estimates.

[3] Includes mobile homes.

[4] Federal Home Loan Bank of San Francisco Housing Vacancy Survey, September 1985. Includes single family attached and detached, multifamily and mobile homes.

[5] West Pittsburg area comprised of Census Tracts 3141 and 3142. Tract 3090p is included in 1980 to compensate for a Census Bureau error. Part of Tract 3141 was annexed to Pittsburg in 1980 Census and is not included in that year's West Pittsburg totals.

SOURCE: With the exception of a few characteristics noted above, the source for the table is U.S. Department of Commerce, 1970 and 1980.

TABLE B.2

HOUSING CHARACTERISTICS
CONTRA COSTA COUNTY, STUDY AREA CITIES AND UNINCORPORATED AREAS

Industry	1975	Percent of Total	1980	Percent of Total	1985	Percent of Total
Construction	10,000	6.4%	13,300	6.5%	18,300	7.4%
Manufacturing	26,100	16.8%	27,900	13.6%	29,100	11.8%
Transportation, Communication, Public Utilities	9,300	6.0%	11,900	5.8%	15,500	6.3%
Wholesale and Retail Trade	37,500	24.1%	56,600	27.6%	69,900	27.4%
Finance, Insurance, & Real Estate	6,300	4.1%	12,200	5.9%	19,000	7.7%
Services	27,600	17.7%	41,400	20.2%	55,800	22.6%
Government	36,500	23.5%	40,000	19.5%	39,400	15.9%
Other (including Argiculture)	2,200	1.4%	2,000	1.0%	2,400	1.0%
Total County Employment	155,500		205,300		247,400	
Percentage Increase 1975-1985			59.1%			

SOURCE: State of California Employment Development Department, May 1986.

EMPLOYMENT BY INDUSTRY IN CONTRA COSTA COUNTY, 1975-1985

TABLE B.3

Table B.3 shows employment in the county for 1975, 1980, and 1985 by major industrial sector. Employment in the decade has grown by 59.1 percent, but this rate of growth has been declining. The annual growth rate from 1975 to 1980 was approximately 6.5 percent, declining to four percent in the following five year period. The sectoral breakdown in Table B.3 indicates growth in the employment shares for the construction, FIRE, trade, and services sectors. In fact, seventy-eight percent of all net job growth between 1975 and 1985 was in either the trade, FIRE, or services sectors.

Structural changes in the regional economy have had an effect on the occupational structure of the county labor market. Table B.4 shows the occupational structure for the county and five study area cities in 1970 and 1980. In the county and all cities (except Brentwood), executive, administrative, and managerial occupations showed relative growth while operators, craft workers, and laborers showed relative decline. This is consistent with the structural shift away from basic manufacturing employment toward information-based industries, commercial, and service activities.

The county labor force has grown considerably over the last 15 years, despite the industrial shifts. Table B.5 shows labor force participation and unemployment data for 1970 and 1980 in the county and five study area cities. Workers over the age of sixteen who are employed or unemployed and actively looking for work are considered in the labor force. The labor force participation rate has grown in the county and corridor cities over the ten year period. The rate of county civilian labor force growth (45.1 percent) exceeds the growth rate in the number of households over the period by five percent, suggesting relatively more people were seeking employment in 1980 than ten years earlier. As with overall employment growth, the rate of labor force growth in the county has slowed from approximately 4.5 percent annually for the period 1970 to 1980 to 2.5 percent for the period 1980 to 1985. The county unemployment rate rose to eight percent in 1983 falling back down to around six percent in 1985.

Public Finance Trends

Table B.6 shows taxable sales in Contra Costa County and the five study area cities for the years 1975 and 1985. This information is an index for the overall level of commercial activity and the potential for government revenue generation through sales taxes. County taxable sales grew by 37.7 percent in real terms over the period, on par with the overall state growth rate of 35.6 percent. However, per capita taxable transactions were seven percent lower in Contra Costa County than in the state in 1985. Since sales taxes comprise only four percent of locally generated county revenues, the effect of this difference on the county budget is minimal.

	Contra Costa County				City of Antioch				City of Brentwood			
	1970	Percent of Total	1980	Percent of Total	1970	Percent of Total	1980	Percent of Total	1970	Percent of Total	1980	Percent of Total
Executive, Administrative, Managerial	22,701	10.8%	86,572	29.1%	773	7.5%	2,827	15.3%	53	5.8%	240	14.5%
Technical, Sales, Administrative Support	95,791	43.3%	104,306	35.1%	3,509	33.9%	6,035	32.7%	296	32.5%	323	19.6%
Service	24,186	11.5%	33,790	11.4%	1,252	12.1%	2,416	13.1%	147	16.1%	296	17.9%
Farming, Forestry, Fishing	1,341	0.6%	3,511	1.2%	38	0.4%	222	1.2%	89	9.8%	137	8.3%
Operators, Fabricators, Laborers, Craft Workers	67,087	31.8%	68,932	23.2%	4,773	46.1%	6,970	37.7%	326	35.8%	654	39.6%
Total Employed	211,006		297,111		10,345		18,470		911		1,650	
1970-1980 Percent Change		40.8%				78.5%				81.1%		

	City of Concord				City of Martinez				City of Pittsburg			
	1970	Percent of Total	1980	Percent of Total	1970	Percent of Total	1980	Percent of Total	1970	Percent of Total	1980	Percent of Total
Executive, Administrative, Managerial	3,366	10.3%	13,044	25.7%	465	7.6%	2,986	26.6%	293	4.5%	2,115	15.7%
Technical, Sales, Administrative Support	15,482	47.2%	19,220	37.9%	2,612	42.4%	3,989	35.5%	1,955	30.1%	4,478	33.2%
Service	3,815	11.6%	6,250	12.3%	827	13.4%	1,371	12.2%	1,201	18.5%	2,057	15.3%
Farming, Forestry, Fishing	93	0.3%	557	1.1%	21	0.3%	98	0.9%	21	0.3%	188	1.4%
Operators, Fabricators, Laborers, Craft Workers	10,018	30.6%	11,590	22.9%	2,229	36.2%	2,784	24.8%	3,017	46.5%	4,638	34.4%
Total Employed	32,774		50,661		6,154		11,228		6,487		13,476	
1970-1980 Percent Change		54.6%				82.5%				107.7%		

SOURCE: U.S. Department of Commerce, 1970 and 1980.

TABLE B.4

OCCUPATION
CONTRA COSTA COUNTY AND STUDY AREA CITIES, 1970 AND 1980

	Contra Costa County			City of Antioch			City of Brentwood		
	1970	1980	1970-1980 % Change	1970	1980	1970-1980 % Change	1970	1980	1970-1980 % Change
Persons 16 Years and Over	379,370	500,757	32.0%	18,404	30,524	65.9%	1,845	3,264	76.9%
Labor Force	226,374	326,530	44.2%	11,065	20,149	82.1%	1,015	1,818	79.1%
LF Participation Rate	59.7%	65.2%		60.1%	66.0%		55.0%	55.7%	
Civilian Labor Force	223,383	324,216	45.1%	10,986	20,040	82.4%	1,015	1,813	78.6%
Unemployed	12,377	18,903	52.7%	641	1,570	144.9%	104	163	56.7%
Unemployment Rate	5.5%	5.8%		5.8%	7.8%		10.2%	9.0%	

	City of Concord			City of Martinez			City of Pittsburg		
	1970	1980	1970-1980 % Change	1970	1980	1970-1980 % Change	1970	1980	1970-1980 % Change
Persons 16 Years and Over	54,509	78,630	44.3%	11,372	17,435	53.3%	13,697	23,152	69.0%
Labor Force	35,059	54,992	56.9%	6,528	11,914	82.5%	7,406	14,825	100.2%
LF Participation Rate	64.3%	69.9%		57.4%	68.3%		54.1%	64.0%	
Civilian Labor Force	33,427	54,425	62.8%	6,001	11,876	97.9%	7,342	14,668	99.8%
Unemployed	1,722	2,877	67.1%	339	648	91.2%	855	1,192	39.4%
Unemployment Rate	5.2%	5.3%		5.6%	5.5%		11.6%	8.1%	

SOURCE: U.S. Department of Commerce, 1970 and 1980.

TABLE B.5

LABOR FORCE PARTICIPATION
CONTRA COSTA COUNTY AND STUDY AREA CITIES, 1970-1980

TABLE B.6

TAXABLE SALES
CONTRA COSTA COUNTY AND STUDY AREA CITIES, 1975 AND 1985
(IN THOUSANDS OF NOMINAL DOLLARS)

	Contra Costa County		City of Antioch		City of Brentwood	
	1975	1985	1975	1985	1975	1985
Retail Stores	1,341,028	3,927,590	87,910	244,728	9,233	22,682
All Other Outlets	434,989	1,168,215	6,863	22,615	1,081	6,625
Total All Outlets	$1,823,174	$5,256,261	$94,773	$167,343	$10,314	$29,307
1975 - 1985 Percent Change*		37.7%		34.7%		35.7%

	City of Concord		City of Martinez		City of Pittsburg	
	1975	1985	1975	1985	1975	1985
Retail Stores	317,494	961,034	23,899	63,464	31,909	104,618
All Other Outlets	46,301	180,461	6,460	21,234	3,305	38,625
Total All Outlets	$363,795	$1,141,495	$30,359	$84,698	$35,214	$143,243
1975 - 1985 Percent Change*		49.9%		33.3%		94.3%

*Percentage change in real dollars after converting to 1967 base year using San Francisco-Oakland CPI data.

SOURCE: State of California Board of Equalization, 1975 and 1985.

The ability to finance city and county services and promote continued economic growth is, in part, dependent on the fiscal strength of government. Table B.7 shows general county financing for the fiscal year 1984 - 1985. The county is reliant on intergovernment grants and transfers and direct taxes for revenue generation. Intergovernment grants and transfers make up fifty-two percent of the county's total revenues while the remainder is generated through county assessments, rents, and charges. The majority of these county generated revenues are property taxes. Over half of all county expenditures were on education, health, and culture programs. The $27 million surplus was carried over into the next fiscal year for anticipated capital expenditures. There are indications the county has relatively more economic resources for revenue generation than other California counties. Per capita net assessed property valuation of $43,630 exceeded the state average by over twenty percent in 1985.

Real Estate Trends

Although Contra Costa County's housing stock rapidly expanded in the 1970's, it was not until the first half of the 1980's that the county experienced phenomenal increases in office development. In 1970, the county contained approximately 750,000 square feet of office space in class "A" buildings, and by 1975 this supply had grown by 300,000 square feet. In the latter half of the 1970's, an additional 2.3 million square feet of office space was constructed in the Cities of Walnut Creek, Concord, San Ramon, and Pleasanton. (Although the City of Pleasanton is located within Alameda County, real estate market analyses frequently include it within discussions of the Contra Costa County market. The inclusion of the City of Pleasanton increases the Contra Costa County office inventory substantially, since Hacienda Business Park is located there.) Between 1980 and 1985 an additional ten million square feet of office space was absorbed, for an annual absorption rate of over two million square feet (Coldwell Banker, Summer 1986). At the end of 1985, an additional nine million square feet of office was under construction. Rent levels ranged between $1.25 and $2.50 per square foot per month for newly constructed buildings. Some of this newly constructed space is located in business parks (Bishop Ranch Business Park in San Ramon with five million square feet), and some is located in large, single tenant buildings, such as Bank of America's one million square feet office complex in the City of Concord.

The corridor along I-680 has been the primary location for new office construction. This corridor spans both Alameda and Contra Costa Counties. In Contra Costa County, the cities of Walnut Creek and San Ramon have received the most growth. The eastern portion of Contra Costa County, the primary location for the transportation alternatives, has not shared in the Central County's office development. Instead, it continues to be a residential area, and workers commute from there to other employment centers. Approximately eighty percent of employed residents in east Contra Costa County commute to jobs located in the west or central portions of Contra Costa County. (Contra Costa County, 1985.)

	Contra Costa County	City of Antioch	City of Brentwood	City of Concord	City of Martinez	City of Pittsburg
TOTAL REVENUES	$328,827,159	$12,807,696	$3,014,247	$47,018,877	$11,108,377	$12,268,969
All Taxes	27.4%	39.9%	40.6%	50.9%	40.9%	28.4%
Intergovernment Grants and Transfers	52.4%	15.8%	11.9%	13.8%	12.1%	38.6%
License and Service Charges	14.1%	31.0%	31.7%	26.2%	37.2%	26.9%
Other	6.0%	13.3%	15.9%	9.2%	9.8%	6.2%
TOTAL EXPENDITURES	$301,393,773	$11,200,423	$1,903,989	$48,568,538	$ 9,217,928	$12,452,703
General Government	9.9%	8.7%	12.3%	7.9%	5.8%	4.9%
Public Safety	29.8%	41.7%	28.2%	24.2%	28.6%	30.7%
Transportation and Public Utilities	6.1%	30.6%	34.4%	15.7%	43.1%	23.1%
Other (including Health Schools, Community Development, Culture)	54.2%	19.0%	25.0%	52.2%	22.5%	41.2%

SOURCE: State of California, Office of the Controller, 1984-1985.

GENERAL COUNTY FINANCING
CONTRA COSTA COUNTY AND STUDY AREA CITIES
FISCAL YEAR 1984-85

TABLE B.7

Real estate development trends in Contra Costa County indicate predominantly residential growth in east county cities and commercial development in central county cities. This pattern is illustrated by Table B.8, which summarizes recent building permit activity in the county and study area cities. Although a building permit does not always result in completed construction, it is a good indicator of future development. In 1985, approximately half of the total valuation of permits for new construction was for residential use. The valuation of permits for the central county cities of Martinez and Concord shows that future development in those cities will favor commercial and industrial construction more than will the east county cities of Antioch, Brentwood and Pittsburg. In the central county portion of the study area, less than fifty percent of building permit activity (in terms of valuation) was for residential construction, whereas in the east portion of the county, more than eighty percent of building permit activity was intended for residential construction.

At present, the suburban office market in Contra Costa County is experiencing high vacancy rates. This is similar to trends throughout the country. Of the eighteen million square feet of office space available at the beginning of 1986 in Contra Costa County, over twenty percent was vacant. Grubb & Ellis, commercial brokers, estimated that the available space represents a two to three year supply of office space. (Grubb & Ellis, 1987.) However, construction of new space continues, in spite of high vacancies, rent concessions and rent reductions needed to attract tenants to occupy vacant space. In part, this may be due to concerns over future growth controls of office construction. In the City of Walnut Creek, such controls have already been adopted affecting construction in the downtown area.

Aside from office development, the county has recently experienced growth in industrial development such as warehouses, retail distribution centers and laboratories. This new development is also located along the I-680 corridor. Much of this development primarily houses economic activities that either support the office developments or are spin-offs from it. Tenants occupy small size spaces, housed in attractive, low-rise buildings. (Grubb & Ellis, 1987.)

Several regional shopping centers are located in Contra Costa County. In order of descending 1982 sales volume, the shopping centers and locations are as follows: Sun Valley (Concord), Willow Shopping Center (Concord), Hilltop Mall (Richmond), County East Mall (Antioch), and El Cerrito Plaza (El Cerrito). The area, however, with the greatest level of 1982 retail sales was downtown Walnut Creek, which includes several major department stores, such as Emporium-Capwell, Nordstrom, and I. Magnin. (U.S. Department of Commerce, 1982.)

According to a recent survey by Coldwell Banker's Commercial Real Estate Services, there is strong demand for retail space located in quality properties. Excluding regional shopping centers, the overall vacancy rate in shopping centers exceeding eight thousand square feet located along the I-680 corridor, State Route 4 and I-580 is approximately seven percent. Monthly rental rates vary by location; the highest rents were found in downtown Walnut Creek ($2.00/square foot), and the lowest rents ($.90 to $1.20/square foot) were found in outlying growth areas, such as the Cities of Pittsburg and Antioch. (Northern California Real Estate Journal, June 8-21, 1987.)

	1985					
	Contra Costa County	City of Antioch	City of Brentwood	City of Concord	City of Martinez	City of Pittsburg
Number of Permits Issued for Single Units	4,650	580	292	576	206	224
Number of Permits Issued for Multiple Units	4,672	728	-	335	314	738
Single Units as a Percentage of All Residential Permits	49.9%	44.3%	100.0%	63.2%	36.6%	23.3%
Total Valuation for New Residential Units (Single and Multiple)	$535,125	$69,240	$12,811	$63,211	$20,380	$41,760
Valuation of New Commercial, Industrial & Other Space	$442,069	$13,628	$496	$113,225	$19,172	$10,610
Residential Valuation as a Percentage of Total Valuation	54.8%	83.6%	96.3%	35.8%	51.5%	79.7%

SOURCE: Security Pacific Bank, December 1985.

TABLE B.8

RECENT BUILDING PERMIT ACTIVITY
(VALUATION IN THOUSANDS OF DOLLARS)

Finally, the county has been an active area for new residential construction, although the level of subdivision activity has varied greatly from year to year. The detached, single family house is still the most popular type of new construction, but there has been a shift toward more multifamily housing. Presently, new housing construction takes many forms, from single family homes on large lots to townhouses, condominiums, and zero lot line homes. The latter two types of housing are built at higher densities, unless they are developed in a cluster surrounded by open space. It is not feasible to develop higher density housing in all areas of the county, due to topological constraints. With the exceptions of Oakley and the City of Brentwood, there is a diminishing supply of flat land available. Vacant land in many of the cities, such as Antioch, is characterized by rolling hills, which limit construction densities.

B.1.2 STUDY AREA TRENDS

Definition of the Study Area

The study area includes jurisdictions and unincorporated areas which would be directly affected by the transit alternatives (the Cities of Concord, Pittsburg and Antioch and unincorporated West Pittsburg) as well as those cities and areas which would be indirectly affected by the transit alternatives (Martinez, Brentwood, and unincorporated Oakley and Clyde). When analyzing study area trends, it is not always possible to provide data on each affected subarea since, in some cases, only city level data are available. Also, there is only sketchy information covering unincorporated areas. Most of the affected cities and areas are in east Contra Costa County, with the exception of Concord, Martinez and Clyde, which are in central Contra Costa County.

The largest city in the study area, and in the county, is Concord, with over one hundred thousand people. The next two largest cities are Antioch and Pittsburg, with 1987 estimated populations of 51,789 and 41,623 respectively. During the decade between 1970 and 1980, all of the cities and areas in east county, except for West Pittsburg and Clyde, experienced a rate of growth in population that was double or triple that of the remainder of the county. For example, the City of Pittsburg grew by sixty percent, the City of Antioch grew by over fifty percent, and the City of Brentwood grew by over forty percent. This compares to a 17.5 percent population growth rate in Contra Costa County. (See Table B.1.) On the other hand, Clyde, a small unincorporated area, showed a decline in population from 1970 to 1980, and West Pittsburg showed only a small increase. (The limited growth rate in West Pittsburg can be partially explained by the annexation of some of West Pittsburg by the City of Pittsburg during the 1970's.) This population increase differential continued into the 1980's. From 1980 through 1986, it is estimated that the growth rate in the Cities of Antioch and Pittsburg was more than double that of the county.

Median family income in 1980 for most of the study area cities was lower than that for the county, with the one exception of Martinez, where 1980 median family income was slightly higher than in Contra Costa County ($27,310 compared to $26,510). (See Table B.1.) In some of the affected areas, real incomes between 1970 and 1980 increased at a faster rate than they did in the county. In other areas, real incomes declined. No consistent regional trend in income growth can be discerned.

Housing Characteristics

Table B.2 presents 1980 median house values and rents for affected cities and areas. With the exception of the Cities of Concord and Martinez, all rents and house values in the corridor are less than those for the county. In the case of the City of Martinez, the 1980 median value for owner occupied housing was $96,000, whereas the county median was $94,300. (City of Martinez family income was also slightly higher than the county's.) Although the City of Concord's median house value of $90,900 was below the county's median value, its 1980 median contract rent of $287 was slightly higher than the county's median of $266. Housing in the City of Pittsburg, and unincorporated Clyde and Oakley was the least expensive in the study area, both for renter and owner-occupied housing. 1985 housing sales data from the Contra Costa County Board of Realtors indicates that this trend is continuing, where the Cities of Martinez and Concord house prices are higher by at least thirty percent than those in the Cities of Antioch and Pittsburg and unincorporated Oakley. (Contra Costa County, 1985.)

Since east county cities are less accessible to the employment centers in Oakland and San Francisco, they were not part of the Bay Area suburban expansion until the last ten to fifteen years. The Pittsburg-Antioch area is becoming a more integral part of the San Francisco Area. Middle income commuters are now moving to the east county area since it provides a supply of affordable new housing. This is creating a mixed housing supply in the Cities of Pittsburg and Antioch comprised of older stock, which is less expensive and located north of State Route 4, and newer housing, which is higher priced and is located south of State Route 4. Over time, it is likely that the housing price differential between east county cities and other cities in Contra Costa County will decrease, since a larger percentage of housing in east county will be newer and marketed towards middle income commuters.

West Pittsburg and Clyde have the oldest housing. None of Clyde's housing was ten years old or less according to the 1980 census, and only twenty percent of West Pittsburg's housing was ten years or less. In contrast, over forty percent of the housing in Oakley and the Cities of Antioch and Pittsburg was recently built. (See Table B.2.)

Between 1970 and 1980, the rate of growth in housing units located in structures with fifty units or more exceeded the growth rate of units in structures of four units or less. However, over three-quarters of the housing stock in all cities is still located in small buildings. The preponderance of small scale residential structures, mostly single family homes, will not immediately change, in spite of higher growth rates in multifamily structures. For example, although the City of Antioch experienced the highest rate of growth of large structures between 1970 and 1980 (almost four hundred percent), the percentage of housing units in large structures only increased by about three percentage points, or from about two to about five percent of the total housing stock. (Derived from Table B.2.)

More recent housing construction trends indicate that the study area cities accounted for 43 percent of newly built housing units in Contra Costa County between 1980 and 1987 (see Table B.9). The City of Antioch contributed the largest share of those new units or slightly over ten percent of the total. The Cities of Concord and Pittsburg were also actively adding housing units during this period.

	Total Growth in Housing Units 1980-1987	Percent of Total Added Each Year							
		1980	1981	1982	1983	1984	1985	1986	1987
City of Antioch	5,008	9.5	7.2	5.5	9.2	5.3	17.3	23.9	22.1
City of Brentwood	697	5.2	11.3	2.3	0.7	2.2	14.3	46.9	17.1
City of Concord	4,081	11.0	6.7	9.1	6.9	7.7	20.6	19.3	18.8
City of Martinez	3,120	7.7	11.5	6.4	7.7	32.7	11.9	6.7	15.4
Oakley	2,061	14.6	3.9	3.5	10.4	14.9	11.4	16.3	25.1
City of Pittsburg	3,633	12.2	14.6	6.8	8.5	5.4	16.4	14.7	21.5
West Pittsburg	1,624	11.6	13.7	1.2	4.6	5.8	8.4	18.7	35.9
Contra Costa County	46,842	13.3	9.9	5.5	6.7	10.9	13.4	16.6	23.7

Source: Contra Costa County, 1988.

RECENT ANNUAL HOUSING CONSTRUCTION (1980-1987)
CONTRA COSTA COUNTY AND STUDY AREA CITIES

TABLE B.9

With the exception of the City of Martinez, the years of greatest construction activity in the study area cities were 1986 and 1987, a time when mortgage interest rates had declined to their lowest level since the late 1970's.

Although over sixty percent of the newly constructed units countywide in 1987 were single family houses, condominiums or townhouses, this ratio varies greatly by city. In Oakley, Antioch and Brentwood, over eighty percent were single family houses, whereas in Concord, Martinez, and Pittsburg, forty percent or less of new units were single family. (Contra Costa County, 1988.)

Economic Trends

Employment data by city and industrial sector are not available, but through examination of county level data and the experiences of major employers, some trends can be estimated. Many county-wide economic trends are also found in some study area cities including the decline of basic manufacturing industries and the growth of FIRE, service and trade employment. Recent shutdowns at the Pittsburg USX Corporation (formerly U.S. Steel) facilities resulted in the loss of over 800 jobs since 1975. However, there remains a sizable manufacturing industrial base which includes paper products, chemicals, and steel production. The Cities of Pittsburg and Antioch have experienced net job growth in spite of the economic structural shifts that have taken place, mostly due to employment growth in the low-wage service and trade sectors.

Data from the Census of Services indicates the two cities gained a total of 923 service sector employees between 1977 and 1982. Service employment grew by 140 percent in each city over the five year period, outpacing the county service sector growth rate of 112 percent. In contrast, the Cities of Brentwood, Concord, and Martinez have all shown service sector employment growth far below the rate of county growth. (U.S. Department of Commerce, Bureau of the Census, Census of Service Industries, 1977 and 1982.)

One of the biggest boosts to the region's economy was the massive relocation of Bank of America employees to the City of Concord, which was completed by the end of 1987. This move has not only brought several thousand new finance industry jobs to the city but promises to spur job growth in supportive services and commercial enterprises.

Table B.10 shows retail employment growth for the county and five study area cities. In the retail sector there have been relatively high employment growth rates in the Cities of Concord and Pittsburg, and low growth in the Cities of Antioch and Brentwood. The City of Concord, as a focus for office development, has experienced commensurate growth in retailing, allowing office workers to shop where they work. Pittsburg's high rate of retail growth is in part due to the relatively low number of retail employees in the city in 1977. In that year, Pittsburg had three retail jobs for every 100 persons living in the city. The ratio for the neighboring City of Antioch was seven to 100 and the county ratio was six to 100. Thus, the city was underserved in retail trades, providing an opportunity for growth which was later realized.

TABLE B.10

RETAIL EMPLOYMENT GROWTH
CONTRA COSTA COUNTY AND STUDY AREA CITIES
1977-1982

Area	1977 Retail Employment	1982 Retail Employment	1977-1982 % Change
City of Antioch	2,501	2,860	14.4%
City of Brentwood	210	221	5.2%
City of Concord	7,237	9,419	30.2%
City of Martinez	664	819	23.3%
City of Pittsburg	783	1,268	61.9%
Contra Costa County	35,939	42,543	18.4%

SOURCE: U.S. Department of Commerce, Census of Retail Trade, 1977 and 1982.

Table B.4 shows that all five study area cities have experienced growth in the labor force participation rate between 1970 and 1980. With the exception of the City of Brentwood, increases in the participation rates were roughly equal to the increase in the county rate. The low labor force participation rate in the City of Brentwood is attributable to the relatively low number of women entering the labor force. The rate for women has remained virtually constant at forty percent in the City of Brentwood throughout the decade, while, in comparison, the county rate for women rose to fifty-three percent by 1980.

Antioch experienced a 145 percent increase in the number of unemployed residents over the period, placing the city's unemployment rate above the county average in 1980. The Cities of Pittsburg and Brentwood had high unemployment rates in both 1970 and 1980.

There is more variation among the five cities in the occupational characteristics of the residents. All five cities have seen high growth in the number of executives, administrators, and managers but the percentage of the total employed remains below the county average. The Cities of Brentwood, Pittsburg, and Antioch have relatively high percentages of operators and laborers and the lowest percentage of managers and administrators, suggesting a community largely comprised of non-professional workers. This is not quite true in the case of the City of Antioch where the percentage of technicians and clerical workers approaches the county average. The occupational structure of the City of Concord and Martinez closely resembles the structure of the county as a whole, evenly distributed among administrators, technicians and clerical workers, and laborers. (See Table B.4.)

Socioeconomic Projections

Population, household, employment and income projections to the year 2000 (and beyond) are available from the Association of Bay Area Governments (ABAG) and are based on assumptions, such as the amount of land available for new development, zoning policies, and transportation conditions. One important assumption is that a sufficient supply of new housing is built to accommodate the needs of new workers in the area. If this supply is not available, then, employment projections would need to be lowered. ABAGs projections assume that traffic conditions will not worsen. (Association of Bay Area Governments, July 1987.) Consequently, ABAG's projections do not represent a base-line condition of what would occur in the absence of transit improvements, since they already assume that traffic conditions will remain the same.

Tables B.11 and B.12 present ABAG growth projections for the region and study area cities for the period 1980 to 2000. Contra Costa County's employment and population growth are projected to increase at a faster rate than that of the nine county San Francisco Bay Area (46.7 percent and 24.7 percent respectively). However, average household income in the county will increase at a slightly slower rate than average Bay Area income (21.2 percent compared to 26.8 percent).

Within the study area, the Cities of Brentwood and Antioch are projected to grow at the fastest rate. However, this is somewhat misleading in the case of the City of Brentwood, since its population in 1980 was so much lower than that of the other study area cities. In fact, although the rate of increase in Brentwood is almost three times that of Antioch, in actual numbers, the increase in population in Antioch is projected to exceed Brentwood's by over 20,000 people. All cities are projected to have average incomes that are lower than the county's average income. The income levels are projected to be about the same in all the study area cities, except Pittsburg, where average income will be substantially lower than in the other four study area cities.

Employment growth is projected to be higher in all study area cities than it is projected to be in the nine-county San Francisco Bay Area. The highest growth rates, again, are for Brentwood and Antioch. In actual numbers, Concord will add the most jobs - over 30,000 between 1980 and 2000. In the Cities of Martinez and Concord, there is a good balance between the number of employed residents and the amount of employment within the city. Although it is not possible to conclude that employed residents are working at local jobs, this possibility is more likely than in the Cities of Brentwood, Antioch and Pittsburg, where there is a greater disparity in projections between the number of employed residents and the level of local employment. This implies that residents of these three cities are more likely to be commuting to other cities than residents in Concord and Martinez.

Public Finance Trends

Table B.6 shows taxable sales growth in the five cities for the years 1975 and 1985. Growth in taxable sales in the Cities of Concord and Pittsburg exceeds the county growth rate.

City fiscal information is shown in Table B.7. Recent audits by the Office of the State Controller indicate all five cities can be considered fiscally sound. But there

	Nine-County San Francisco Bay Area	Contra Costa County	City of Antioch	City of Brentwood	City of Concord	City of Martinez	City of Pittsburg
Population	24.7%	33.7%	80.4%	219.8%	9.5%	36.6%	45.1%
Households	30.0%	46.9%	105.4%	273.5%	21.9%	49.8%	60.7%
Household Size	-4.3%	-9.3%	-12.0%	-13.7%	-10.0%	-10.2%	-10.1%
Employment[1]	46.7%	74.9%	108.4%	130.8%	91.4%	63.0%	66.3%
Employed Residents	40.8%	55.2%	125.9%	326.9%	26.8%	59.4%	75.5%
Mean Household Income in Constant 1985 Dollars	26.8%	21.2%	37.4%	29.5%	20.5%	18.8%	21.5%

1 The employment indicator represents the total number of jobs in the area, some of which are held by local residents, and others which are held by workers outside the area.

1985-2000 estimates are for April 1 of each year. 1980 numbers are actual values.

Source: Association of Bay Area Governments, July 1987.

GROWTH PROJECTIONS, 1980-2000
CONTRA COSTA COUNTY AND STUDY AREA CITIES
PERCENT CHANCE, 1980-2000

TABLE B.11

CONTRA COSTA COUNTY

	1980	1985	1990	1995	2000	% Change 1980-2000
Population	656,380	705,000	777,000	829,200	877,900	33.7%
Households	241,534	263,370	298,420	327,160	354,720	46.9%
Household Size	2.69	2.64	2.57	2.50	2.44	-9.3%
Employment[1]	202,166	236,900	287,500	326,400	353,500	74.9%
Employed Residents	307,476	350,100	402,400	446,600	477,100	55.2%
Mean Household Income in Constant 1985 Dollars	$39,040	$42,500	$44,100	$45,800	$47,300	21.2%

CITY OF ANTIOCH

	1980	1985	1990	1995	2000	% Change 1980-2000
Population	45,961	50,900	59,000	70,400	82,900	80.4%
Households	16,142	18,010	21,750	27,080	33,160	105.4%
Household Size	2.83	2.80	2.69	2.58	2.49	-12.0%
Employment[1]	8,732	10,300	12,300	16,200	18,200	108.4%
Employed Residents	20,056	23,400	29,400	38,200	45,300	125.9%
Mean Household Income in Constant 1985 Dollars	$32,376	$35,400	$38,800	$41,900	$44,500	37.4%

GROWTH PROJECTIONS, 1980-2000 TABLE B.12
(Continued on next page)

CITY OF BRENTWOOD

	1980	1985	1990	1995	2000	% Change 1980-2000
Population	6,785	7,300	8,800	12,700	21,700	219.8%
Households	2,233	2,440	3,060	4,670	8,340	273.5%
Household Size	3.00	2.97	2.82	2.70	2.59	-13.7%
Employment[1]	1,083	1,400	1,800	2,100	2,500	130.8%
Employed Residents	2,577	3,000	3,700	6,000	11,000	326.9%
Mean Household Income in Constant 1985 Dollars	$31,649	$35,100	$36,500	$38,100	$41,000	29.5%

CITY OF CONCORD

	1980	1985	1990	1995	2000	% Change 1980-2000
Population	104,800	107,400	111,300	113,800	114,800	9.5%
Households	38,322	40,430	43,350	45,350	46,710	21.9%
Household Size	2.70	2.63	2.54	2.48	2.43	-10.0%
Employment[1]	33,912	43,600	54,900	59,600	64,900	91.4%
Employed Residents	53,403	58,300	62,600	66,800	67,700	26.8%
Mean Household Income in Constant 1985 Dollars	$35,606	$38,800	$39,200	$41,200	$42,900	20.5%

GROWTH PROJECTIONS
(Continued on next page)

TABLE B.12

CITY OF MARTINEZ

	1980	1985	1990	1995	2000	% Change 1980-2000
Population	30,822	36,100	39,400	41,400	42,100	36.6%
Households	11,405	13,630	15,300	16,400	17,090	49.8%
Household Size	2.65	2.59	2.50	2.45	2.38	-10.2%
Employment[1]	11,348	13,600	15,900	17,700	18,500	63.0%
Employed Residents	15,123	18,800	21,500	23,300	24,100	59.4%
Mean Household Income in Constant 1985 Dollars	$36,695	$40,500	$40,700	$42,800	$43,600	18.8%

CITY OF PITTSBURG

	1980	1985	1990	1995	2000	% Change 1980-2000
Population	43,843	50,400	58,600	61,700	63,600	45.1%
Households	15,207	17,530	21,190	22,990	24,440	60.7%
Household Size	2.87	2.86	2.75	2.66	2.58	-10.1%
Employment[1]	10,702	11,500	13,600	16,500	17,800	66.3%
Employed Residents	17,205	20,800	25,900	28,300	30,200	75.5%
Mean Household Income in Constant 1985 Dollars	$27,651	$30,700	$32,400	$32,900	$33,600	21.5%

1 The employment indicator represents the total number of jobs in the area, some of which are held by local residents, and others which are held by workers outside the area.

1985-2000 estimates are for April 1 of each year. 1980 numbers are actual values.

Source: Association of Bay Area Governments, July 1987.

GROWTH PROJECTIONS, 1980-2000

TABLE B.12

are other indicators of fiscal strength which should be considered besides a city's ability to balance the budget. Per capita retail sales and net assessed property valuation are two of them. The Cities of Martinez and Pittsburg had low per capita retail sales levels that were just over half the countywide average figure in 1982. Concord's per capita retail sales were well above the county average indicating a relative strength in generating sales tax revenues. Per capita net assessed property value for all five cities was below the county average in fiscal year 1984-1985. This puts the study area cities at a disadvantage in their ability to generate revenue through property taxes.

The City of Brentwood has had consistently high budget surpluses since the recent enactment of a construction development tax ordinance. The ordinance provide funds for water, sewer, street, storm drain, and park improvements. The money cannot be used for the general fund and has not been expended, accounting for high budget surpluses.

With the exception of the City of Pittsburg, the five cities have similar revenue source distributions, taking in around forty percent of total revenues through tax assessments, the majority being sales taxes. Pittsburg has received over twenty-four percent of its total revenues in federal grants, far above the California city average (not including San Francisco City and County) of 6.3 percent. These grants were Community Development Block Grants for capital improvements and housing rehabilitation. (Randy Jerome, June 24, 1987.) The sales tax revenue share in Concord and Antioch was almost twice the twelve percent average for California cities, reflecting these cities' reliance on commercial activity for city revenues.

The expenditure distribution varies widely among the five cities. The share of total expenditures spent on culture and leisure in Concord and Pittsburg was far above average California city share. The City of Antioch had relatively high expenditures on public safety, while the City of Concord had lower expenditures for public utilities, in part due to a municipal sewage treatment system.

Local Real Estate Trends

The following section briefly summarizes local real estate trends in many of the study area cities and unincorporated areas. (General sources include: Grubb & Ellis, 1987; Northern California Real Estate Journal, June 8-June 21, 1987; and Coldwell Banker, Summer 1987.)

- City of Martinez has experienced some of the new office development which is occurring along I-680; however, the city accounts for only three percent of the approximately twenty million square feet of office space in the I-680 corridor, compared with the City of Concord, which contains fifteen percent.

- City of Concord, the largest city in Contra Costa County, has experienced significant growth in office and industrial development. At the end of 1985, Coldwell Banker estimated that existing inventory in Class "A" office buildings was approximately 3.5 million square feet, an additional one million square feet was under construction, and the vacancy rate in existing space was approximately eighteen percent. As of February 1988, industry

experts estimated that one million square feet of office space was vacant, so that the vacancy rate neared 30 percent. However, given the building moratorium in Walnut Creek and stabilized rents in Concord, it is possible that absorption will not be a problem. (Northern California Real Estate Journal, February 29, 1988.) A Concord Redevelopment Agency market study estimated that annual absorption in City of Concord office space averaged approximately 200,000 square feet annually from 1982 to 1984. (Economic Research Associates, April 1985.) The cost of existing space was between $1.12 and $2.00/square foot per month. (The City of Concord's vacancy rates and rent levels are similar to those for the county.)

Although a large majority of office space had formerly been occupied by tenants engaged in wholesale, retail and manufacturing operations, new space since 1984 has been successfully marketed to firms in the more traditional "office-type" operations, such as banks and data processing. Some of the office space is now occupied by large single tenants, such as Chevron and the Bank of America. Quality industrial space is also being developed in the City of Concord; in 1986, over two hundred thousand square feet of industrial space was under construction.

In an effort to spur downtown development adjacent to the Concord BART station (which is the terminus for the Daly City-Concord line), the city created a redevelopment district in downtown Concord. So far, redevelopment has been successful in attracting new office, residential and commercial construction. The area is still undergoing redevelopment. There are several new office projects immediately adjacent to the Concord BART Station. One Concord Centre is the highest building in the County at fifteen stories. Gateway I and Gateway II are twin office buildings. Gateway II is nearing completion and is still vacant, and Gateway I is fully leased. Finally, BART plans a multiuse, joint development project on BART-owned land at the Concord BART station. The proposed project would contain 500,000 square feet of office space in two towers, a 300-400 room hotel, and a theatre. Since this project would be constructed on land that is currently used as surface parking, two 900-space BART patron parking garages would also be built. (The hotel and office projects would each provide their own parking on-site.) The hotel will be developed first, and BART will lease the land to a hotel operator/developer on a long-term lease. (Mundie & Associates, March 1988 and Kerry O'Banion, April 11, 1988.)

- West Pittsburg's new development has primarily been residential. At the end of 1986, over two thousand housing units were either under construction, approved for construction or pending approval. About two-thirds of these units are to be located in multifamily structures, at densities ranging from 13.5 units per acre to 27 units per acre. (Contra Costa County, September 1986.) The single largest residential complex planned is Sea Breeze Apartments, which would result in the construction of five hundred apartment units. (Contra Costa County, May 1986.)

  Contra Costa County has recently established a new redevelopment project area in West Pittsburg, covering the majority of this unincorporated area.

The goals of redevelopment include improving major arterials (Port Chicago Highway and Willow Pass Road), assisting in construction and rehabilitation of housing, and encouraging commercial and industrial development. Tax increments will be used to fund this project.

- City of Pittsburg for several years has worked to revitalize its downtown area. The main city strategy at present for downtown redevelopment is to market downtown sites actively to private developers and to provide developers with economic incentive grants, to assist financing for infrastructure development and provide tax incentives. In this way, developers can build and operate developments at lower costs. The chief funding mechanism for redevelopment is the Los Medanos Project Area redevelopment plan adopted in 1979. This redevelopment area covers approximately seventy percent of the city. The intent is to use property tax increments from the new residential construction south of State Route 4 to revitalize the downtown area and fund infrastructure improvements in developing areas. (Contra Costa County, 1986.)

  Much of the BART and LRT alignment along State Route 4 in the City of Pittsburg runs through this redevelopment area - specifically, the segment beginning approximately one to two miles west of Railroad Avenue and ending just west of Somersville Road. The same is true of the Southern Pacific Railroad LRT alignment, although the segments passing through the redevelopment area are somewhat different since the SP alignment is further north. Specifically, the SP alignment enters the redevelopment area east of Jimno Avenue (just west of the Railroad Avenue Station), and continues through the City of Pittsburg until just west of Loveridge Road. Then, between Standard Oil Avenue and Somersville Road, the SP railroad tracks form the northern boundary of the redevelopment area.

  Another redevelopment project is to encourage reuse of industrial facilities which are no longer operating at capacity. These facilities are primarily owned by USX Corporation (formerly known as U.S. Steel) and by Dow Chemical USA. USX Corporation, in conjunction with a South Korean Steel Corporation, is modernizing its plant and attracting additional tenants who would use the output of the steel plant. (Northern California Real Estate Journal, June 8 - June 21, 1987.)

  In March 1988, the City of Pittsburg's request for a portion of the city to be declared an Enterprise Zone succeeded. Although the principal goal of an economic incentive area is primarily to encourage employment, there are indirect benefits to real estate development. Some of these incentives relevant to real estate development include: capital improvements to city infrastructure and city fee waivers and reductions for new construction and rehabilitation (Borunda 1988).

  More of the BART and LRT alignment along State Route 4 in the City of Pittsburg runs through this Enterprise Zone than does the LRT alignment along the Southern Pacific Railroad tracks. Beginning at Lido Way and continuing until east of Railroad Avenue, the State Route 4 alignment is in the Enterprise Zone. The State Route 4 alignment re-enters the Zone at

approximately Diane Avenue and exits at Standard Oil Avenue. One segment of the LRT alignment along the SP tracks that is located in the Enterprise Zone runs along either side of the SPT Co. Depot. A second segment enters just east of Standard Oil Avenue and continues in the Enterprise Zone until Somersville Road. (This second segment is the northern boundary of the Enterprise Zone.)

In addition to revitalizing downtown and redeveloping industrial areas, the City of Pittsburg is currently redeveloping its marina area. The marina project includes demolishing older housing units and constructing four hundred new townhouses and a two hundred boat facility at the marina. Additional new development is underway at a vacant area known as the Baker property. Various development scenarios have been proposed, ranging from a high development scenario of 1.7 million square feet to a low development scenario of 1.3 million square feet. Both development scenarios would include a major shopping center of at least 700,000 square feet. Under the high development scenario, additional light industrial and commercial space would be built. Under the low development scenario, the additional space would be developed as warehouse space. (Larry Seeman Associates, September 1986.) A Target Store has already been completed at this site.

Residential construction is projected to continue at a fast rate. Over 3,000 additional units are planned, the majority of which are multiple housing units. Additionally, a large development of 3,000 units is slated for an area that was formerly a Chevron tank storage area (at Somersville and Buchanan). About half of these units will be located in the City of Pittsburg and about half in the City of Antioch. In the City of Pittsburg, most new residential construction is located in the foothills south of State Route 4.

- City of Antioch currently has over one million square feet of retail and commercial space. Approximately half of this space is accounted for by two adjacent shopping centers in West Antioch (County East Mall and Delta Fair). Several additional shopping centers are either under construction or are already completed. Recent commercial projects near the proposed West Antioch BART/LRT station include Delta Square Business Park (50,000 square feet) and Orchard Square (100,000 square feet). A smaller retail Center, Sunset Plaza, has been approved at a site immediately to the north of the proposed East Antioch BART/LRT Station. (City of Antioch, March 1988.) Leasing rates vary by location within Antioch; the space near the major shopping centers (Somersville Road/Delta Fair Boulevard/Buchanan Road) is the most expensive at $1.00/square foot per month. (This rate, however, is lower than other areas in the county.) (City of Antioch, 1986.)

  The City of Antioch created a redevelopment project in 1986 that encompasses the East Antioch BART/LRT station. The goal of the redevelopment project is to improve area access, storm drainage, sewer and water problems, mixed land use, and fragmented parcelization. Additionally, it intends to upgrade existing development and encourage new development. The redevelopment area consists of four subareas, one of

which is the alternative BART/LRT station, and the remainder of which will either be developed in residential or industrial uses. (City of Antioch, October 1986.)

Finally, residential construction in Antioch is projected to be very active. At least 15,000 more housing units are being planned. Southeast Antioch is the most active area for new construction, located at a distance from any of the proposed BART or LRT stations. (Contra Costa County, April, 1988.) There is a Southeast Specific Plan covering this part of Antioch. This planning area is located immediately south of the BART/LRT State Route 4 alignment, beginning at Lone Tree Way and continuing until the terminus at the East Antioch Station. (City of Antioch, 1982.)

B.2 ENVIRONMENTAL CONSEQUENCES

The 12 alternatives being evaluated vary in the degree to which they would cause economic impacts, because they differentially improve accessibility within the corridor and region. The rail alternatives (alternatives 4 through 8) would improve regional accessibility more than Alternatives 1, 2, 3, and 3A.

As accessibility is improved, the advantages of living and doing business in the Pittsburg-Antioch Corridor increases. Since proximity to the transportation system is an advantage for system users, often more concentrated growth occurs around station areas. This growth is possible if local governments increase allowable densities in the immediate vicinity and/or higher density development is economically feasible.

Furthermore, improved accessibility can either lead to more regional growth or to a redistribution of growth. More regional growth occurs if the amount of development increases adjacent to station areas, but does not decrease elsewhere in the region. Redistribution of growth occurs if development increases near station areas, but decreases elsewhere in the region, due to public policy or economic constraints. The more perceptible impacts result from a redistribution of growth within the region, and not from absolute growth of the region.

Table B.13 summarizes the economic/demographic impacts from the various system alternatives. There are no significant impacts from Alternatives 1, 2, 3, and 3A. Among the rail alternatives, Alternative 6 (BART to North Concord/Martinez) has the fewest impacts, since it would cover the shortest distance. Alternative 7 (BART to Antioch) would have the greatest impact since it could increase transit-accessible employment opportunities and lead to corridor and station area development, given supportive local policies. Impacts from LRT Alternatives 4, 4A, and 5 are similar to those from Alternative 7 (BART to Antioch), but to a lesser degree because of less patronage. However, none of the economic impacts are significant.

The following section explains these impacts from the corridor alternatives. They are grouped as follows: nonrail Alternatives 1, 2, 3, and 3A and rail Alternatives 4, 4A, 5, 6, 7, 7A, 7B, and 8. First, impacts of the alternatives on study area population, employment, and real estate development are examined. Second, localized development impacts are discussed. Finally, the revenue impacts, potential for value capture revenues, and construction and operation employment impacts are presented.

	Alternative						
Potential Impacts	1	2	3	3A	4	4A	5
Regional Population	None	None	None	None	None	None	None
Regional Employment	None	None	None	None	Some increase in transit-accessible employment.	Some increase in transit-accessible employment.	Some increase in transit-accessible employment.
Regional Real Estate Development	None	None	None	None	Given supportive local policies, there could be a clustering of intensive development along transit corridor.	Given supportive local policies, there could be a clustering of intensive development along transit corridor.	Given supportive local policies, there could be a clustering of intensive development along transit corridor.
Station-by-Station Development	None	None	None	None	Given supportive local policies, there could be more intensive development adjacent to some station areas.	Given supportive local policies, there could be more intensive development adjacent to some station areas.	Given supportive local policies, there could be more intensive development adjacent to some station areas.
Revenues and Tax Base	None	None	None	None	Minimal	Minimal	Minimal
Employment Impacts of Construction and Operation (will be summarized later)							

SUMMARY OF ECONOMIC/DEMOGRAPHIC IMPACTS OF SYSTEM ALTERNATIVES

Table B.13

Potential Impacts	Alternative 6	7	7A	7B	8
Regional Population	None	None	None	None	None
Regional Employment	Minimal increase in transit-accessible employment.	Increase in transit-accessible employment.	Minimal increase in transit-accessible employment.	Some increase in transit-accessible employment.	Some increase in transit-accessible employment.
Regional Real Estate Development	Some clustering of intensive development along transit corridor but less so than Alternatives 4, 4A, 5, 7, 7A and 7B.	Given supportive local policies, there could be a clustering of intensive development along transit corridor.	Some clustering of intensive development along transit corridor but less so than Alternatives 4, 4A, 5, 7, 7A and 8.	Given supportive local policies, there could be a clustering of intensive development along transit corridor.	Given supportive local policies, there could be a clustering of intensive development along transit corridor.
Station-by-Station Development	No impact, due to Naval Weapons Station.	Given supportive local policies, there could be more intensive development adjacent to some station areas. Impacts would be greater than for Alternatives 4, 5 or 8, however, they would not be significant.	Given supportive local policies, there could be more intensive development adjacent to West Pittsburg Station.	Given supportive local policies, there could be more intensive development adjacent to the West Pittsburg and Pittsburg station areas.	Given supportive local policies, there could be more intensive development adjacent to some station areas. (An intermodal transfer station is usually a good candidate for more intensive development. However, since North Concord is surrounded by the Naval Weapons Station, the development advantages are more limited.)
Revenues and Tax Base	Minimal	Minimal, but greater than Alternatives 4, 5, or 8.	Minimal	Minimal	Minimal
Employment Impacts of Construction and Operation (will be summarized later)					

SUMMARY OF ECONOMIC/DEMOGRAPHIC IMPACTS OF SYSTEM ALTERNATIVES

Table B.13

B.2.1 REGIONAL GROWTH

Population Impacts

Forecasts of population growth provided by ABAG are predicated on several assumptions, one of which assumes that traffic conditions do not worsen. Consequently, ABAG's projections do not represent a baseline forecast of population growth in the absence of transit improvements.

In general, an improvement in infrastructure alone is insufficient to lead to major population changes. Other factors, such as availability of employment and housing, are more critical. It is unlikely, therefore, that an improvement in the transportation system - be it a rail or non-rail alternative - will lead to a change in projected corridor area or regional population growth. (UMTA guidelines for transit project planning issued in September 1986 reflects this assumption.) The more likely effect would be to increase development around station areas, which could increase population at station area locations, if the development included a residential component. A transportation system improvement could also result in an increased rate of population growth along the corridor area if market demand responded to improved accessibility of the area.

Employment Impacts

The corridor area has experienced expansion in employment in the past twenty years and is projected to continue employment expansion, but probably at a rate that is less than the rate of household growth in the East County cities of Pittsburg, Antioch and Brentwood. One of the problems faced in the corridor is the geographic imbalance between employment and residential growth. Job growth is occurring in central Contra Costa County and in other San Francisco Bay Area counties, whereas the housing supply is expanding in the east county cities without commensurate job growth. In fact, if one examines the ratio of locally available jobs to employed residents, the ratios in the east county cities are projected to be mostly below .45 by the year 2000, except for the City of Pittsburg which is projected to be approximately .60. (A ratio of 1.00 would indicate that there was a job available for every employed resident.) In contrast, in other regions of the San Francisco Bay Area, for example Santa Clara County, the ratio is greater than 1.00. (Contra Costa County, 1987.)

This imbalance results in long commutes and over-crowded streets and highways, particularly along the State Route 4 corridor. If the transportation system could be improved in the Pittsburg Antioch Corridor, then job opportunities would be more accessible to the labor force in the corridor. Rail alternatives would improve commuting conditions to a greater degree than the non-rail alternatives, since the rail alternatives include most of the non-rail improvements, as well as the benefits of rapid transit opportunities. The one exception is BART to North Concord/ Martinez, which would not provide direct rail access to regional employment opportunities for the labor force living in the east county area. The labor force living in the east county area would need to drive to the North Concord/Martinez BART Station. Since this trip would entail a drive of 10 to 15 miles or more, it is unlikely that there would be a major change in commuting patterns except for those east county workers who had avoided using BART, due to the congestion in downtown

Concord. Since the North Concord location would be less congested, they might then utilize BART and therefore benefit from rapid transit.

If a rail alternative was selected, workers would be less auto-bound. Furthermore, it is possible that a rail alternative would lead to more intense land uses around stations. If these were employment-generating land uses, then workers could find transit-accessible employment opportunities expanded. Although it is likely that regional employment levels would not rise, it is likely that:

- Workers could experience an improved quality of life through shorter or more problem-free commutes; and

- Employment could be more concentrated around LRT or BART stations.

B.2.2 REGIONAL REAL ESTATE

Impacts of the Alternatives on Corridor Development

The Pittsburg-Antioch Corridor has experienced rapid development in the past twenty years. In the last ten years, there has been expansion of office space and some light industrial development along the northern I-680 corridor. This development is expected to slow during the 1990's; however, residential and retail construction in the eastern portion of the county should continue.

At present there are several constraints (water, sewer, etc.) on development within the corridor area, including congestion along State Route 4. Most cities need to expand services or infrastructure to accommodate additional growth. These constraints are expected to be temporary, since in all cases, infrastructure expansions are planned. For example, the City of Antioch needs to expand its water plant, the City of Pittsburg needs to expand school capacity, and West Pittsburg needs additional water storage capacity. The one exception is the City of Brentwood, where inadequate sewer and water services have recently served to constrain development. Development fees vary by jurisdiction, but for the most part, are fairly typical of fees assessed by California cities. These include fees for road improvements, park dedication, and schools.

Real estate development is affected the most along the transit alignment itself because the immediate advantages for commercial (and to a lesser degree, residential) development occur within close proximity to the alignment. Reasons for this include visibility of signs from the BART/LRT trains (serving as advertisement for the commercial development) and ease of accessibility to transit stations. Transit may affect the nature and timing of new development on vacant land or redevelopment of areas already developed. Given the abundance of vacant land along the alignment, it is more likely that development impacts would be greater on future new development than on redevelopment; however, none of the impacts is significant. The following list summarizes the amount and nature of vacant land along the alignment and current general plan designation for these areas.

City of Concord Developable Land (Adjacent to All Rail Alternatives)

Development opportunities continue to exist in the downtown redevelopment area of the city, particularly in the area along Willow Pass Road (west of Galindo) and the area west of Todos Santos Plaza, bounded by Concord Avenue, Salvio Street, and Sutter Street. These areas are designated for mixed commercial/residential and office development. North of State Route 4 there are additional development opportunities in the industrial area west of Port Chicago Highway, particularly in the vacant land parcels south of Bates Avenue, adjacent to State Route 4. Although this area is fairly remote from the alignment, it is one of the few areas of vacant land near the North Concord/Martinez Station. This area is suitable for warehouse, research and development (R&D), or light manufacturing uses. Transportation impacts on development vary along this segment of the alignment. In the downtown Concord area, the existing BART station may have encouraged higher density development.

West Pittsburg Developable Land (Adjacent to All Rail Alternatives, Except Alternative 6)

There is vacant land along State Route 4 from Willow Pass Road in Concord to Willow Pass Road in West Pittsburg. It is hilly terrain and designated as open space by Contra Costa County. South of State Route 4 there is vacant land designated for low density housing (a maximum of seven units per acre). This area extends almost to Bailey Road. Additionally, two undeveloped sites have been designated as shopping centers; one is at the intersection of Willow Pass Road and Port Chicago Highway, and the other is on the west side of Bailey Road between State Route 4 and West Leland, adjacent to the BART park-and-ride lot. High density housing is planned for the vacant lot west of the proposed Bailey Road shopping center.

The planned State Route 4 interchange at Range Road may provide opportunities for low density residential development in the nearby vacant parcels to the south. Finally, vacant land along the SPTC tracks near the Shell property, east of Port Chicago Highway, is designated for industrial use. Development impacts are mixed. Some of the vacant land cannot be developed on because it is hilly. Other vacant land will already be developed as low density housing before the rail system is extended. The primary development impact will be on the planned shopping centers and high density housing. However, since the planned developments would be completed before there was a BART or LRT extension, there would be no impacts on initial financial feasibility of these projects. In the long run, however, these projects could experience greater cash flow than would otherwise be possible.

City of Pittsburg Developable Land (Adjacent to Alternatives 4, 4A, 5, 7, 7B, and 8)

There are large plots of vacant land as well as land with vacant industrial buildings to the east of the city. North of the SPTC tracks are 195 acres of vacant land lacking infrastructure and 104 acres of land with vacant industrial buildings. Between the railroad tracks and State Route 4 east of Harbor Street to Somersville Road are 146 acres of vacant land designated for industrial or industrial park use, and an additional 85 acres of vacant land designated for a shopping center. Seeno Construction Company owns most of this land (referred to as the Baker property). Construction has already begun on a new shopping center along Century Boulevard.

North of the railroad tracks are 58 acres of vacant and available space in industrial and other structures. Most of this space is part of the U.S. Steel property and is being marketed by U.S. Steel Realty Corporation as an industrial park.

This segment of the alignment could experience the greatest development impacts from a rail extension, since there is so much vacant land, and land that is being redeveloped. Again, it is a question of whether these vacant lands are developed in low density uses, primary industrial and warehouse, before the system is developed. If that occurs, then, there is a smaller benefit from transit, since transit is most beneficial for commercial, office, and residential uses. (There are a greater number of employees, customers, and residents in these latter uses than in industrial uses, which tend to be land intensive.) This is one of the alignment segments where delaying development until a market develops for more intensive uses could lead to more beneficial development impacts.

City of Antioch Developable Land (Adjacent to Alternatives 4, 4A, 5, 7, and 8)

There are about 200 acres of vacant land located south of State Route 4 and north of Buchanan Road, between the Los Medanos Waterway and slightly to the east of Somersville Road. This area has been designated for commercial and multifamily residential use. On the west side of Antioch are 500 acres of mostly vacant land located to the west of Somersville Road and north of the SPTC tracks. This area is zoned as a planned industrial district. U.S. Steel Realty has recently subdivided this area to market the land.

Directly south of the downtown Antioch area are some scattered vacant residential parcels along Lone Tree Way, south of State Route 4. However, the majority of the vacant land in Antioch is concentrated on the east side of the city. Proposed development for this area is discussed in three separate specific plans. One of these, the Southeast Antioch Area Plan, covers approximately 5,000 acres. The anticipated population in this area is estimated to be 44,400 residents. Currently, most of the land in this planning area is vacant. Much of the vacant land is zoned either for industrial or residential use. As mentioned above, industrial uses benefit less from a transit system than do more intensive uses. Another planned land use in this area is residential. Some of this is multifamily, and some is single-family. Although the market favors single-family housing in this area, there would be more direct benefits to multifamily housing from a system extension. Again, this is an area where delaying development currently supported by the market (industrial and single-family residential uses) could lead to more beneficial development impacts in the long run. Finally, the area surrounding the East Antioch station is partly vacant and located within a redevelopment area.

Additional Sources of Developable Land

In addition to these large tracts of vacant land, there is other land available for development. For example, publicly encouraged redevelopment of improved sites provides another source of developable land. Several cities are planning and implementing downtown redevelopment activities. The City of Concord is by far the most active, but the City of Pittsburg is also redeveloping its downtown area, primarily through facilitating private sector activities and improving infrastructure.

Yet another source of developable land can be parcels which currently have a low intensity use, but could be developed at a higher use once market demand increased. In the Pittsburg-Antioch corridor area this type of redevelopment could be decades away. Market demand is not yet strong enough, and there is an abundance of vacant land along the corridor, which would not require demolition and removal of existing structures in order to develop.

As with employment, the rail alternatives (as compared to Alternatives 1, 2, 3, and 3A) would have the greatest impact on new development. Transit could serve as an amenity to new residential, retail, office and R&D development. Transit, particularly BART, improves accessibility of the corridor area to other points within the San Francisco Bay Area. Consequently, sites that would formerly be out of the Pittsburg-Antioch labor and retail market areas would now be located within them. For residents and employers, this means that they can consider a wider geographic range for employment, and for retailers, possibly an expanded customer base. Although the corridor area may not experience more development overall, the transit alternatives could serve to cluster intensive development adjacent to station areas, if market demand were present.

Currently, much of the vacant land along the corridor is designated for industrial use, particularly adjacent to the light rail alignment (Alternative 5). Industrial space has a lower FAR and fewer employees in a given area than does office or commercial space. Consequently, given the nature of planned new development, there could be little impact on new development from an expanded transit system. This is because there would be fewer patrons (in this case employees) benefitting from transit accessibility. It can be argued that more intensive development on corridor vacant lands could result in higher land values than would industrial development. The location of the Pittsburg-Antioch corridor is well-situated for office, commercial and service functions. Although it is not near San Francisco, it is centrally well-located with respect to Solano and San Joaquin Counties - both of which are high growth areas. Over time, the proximity of the Pittsburg-Antioch Corridor to these two growth areas should increase demand for sites located within the corridor. This demand could augment the potential for increased demand due to transit, thereby making intensive development more financially feasible. Although demand for these other land uses may be several decades into the future, it could be there by the time the transit system could be operating.

Mitigation Measures

Clustering of development along the rail alignment (particularly for Alternative 7 [BART to Antioch]) is desirable for a number of reasons. It could:

- Increase system patronage,
- Reduce auto-dependency and congestion,
- Increase alignment area land values, and
- Allow cities to control and focus growth while reducing traffic impacts.

The presence of a transportation system, in itself, would not result in more intensive development along the alignment until there is adequate market demand and supportive local land use policies are enacted. If that market demand is to be realized in intensive alignment development, then local zoning policies need to be

supportive. At present, much of the vacant corridor land is designated for industrial development which is not intensive. Affected cities and Contra Costa County may want to review their general plan policies regarding this industrial land and consider the following, if encouragement of corridor development is desired:

- Increase Floor Area Ratios (FAR's) for new development located along the alignment, particularly adjacent to station areas.

- Allow density bonuses for development around transit stations.

- Reconsider general plan use designations, and where appropriate, modify those policies to promote intensive land uses that can be benefitted by transit, such as alignment areas in the cities of Pittsburg and Antioch.

B.2.3 STATION-BY-STATION

Development Impacts

This section discusses impacts of the rail alternatives (alternatives 4 through 8) on station area real estate development patterns. The non-rail alternatives are not addressed in this section for the following reasons. Alternative 1 would not result in any new stations or park-and-ride facilities and although alternatives 2, 3, and 3A would result in new park-and-ride lot areas, significant changes in real estate development patterns would not occur. The principal mechanism through which LRT or BART stations affect development potential of surrounding sites is by increasing rents that can be charged for use of those sites. Projected revenues are then higher, yielding greater cash flow, which, in turn, increases projected return on an investment. In turn, this often modifies financial feasibility of projects that can be erected on those sites. In other words, a project which could not be developed at prevailing (pre-transit) rent levels may become financially feasible when a transit station is constructed.

Critical to this process is the ability to charge higher rents for a station area site. The main explanation for the ability to charge higher rents is improved accessibility. The sites are more accessible to other areas within the region. This is particularly true of BART, because BART improves regional accessibility to a greater degree than LRT. (BART is a regional system, travels faster than LRT, and does not require an intermodal transfer, which can increase travel time.) Retail, residential, and office space users receive benefits. For example, retailers find that, given similar market conditions, they can expect to attract more customers to a site adjacent to a transit station than would otherwise be possible at a distance further away, since customers can use the transit system for travel. Also retailers expect that BART patrons will be customers. Because retailers expect higher sales at a location adjacent to a transit station, they are willing to pay higher rents. Also, employers pay more rent for office and R&D locations adjacent to a transit station, since they anticipate that their workers will find that proximity to transit is a noncash benefit of their employment.

The one exception to the potential increase in rents and land values due to transit is the situation in which residences nearest a station may possibly experience a decrease in value due to station and track visibility and noise. This possibility is more likely to occur in single family residential areas.

For each BART and LRT station, Table B.14 briefly summarizes adjacent land uses, future development scenarios (or redevelopment plans), and impacts of a transit station on future development around the station based on the potential effects of increased rents discussed above. Based on the information in Table B.14, Table B.15 groups the alternative BART and LRT stations into four categories which evaluate the likelihood that transit will affect development or redevelopment around station areas. The primary factor of importance in determining these impacts is the probability that the proximity of transit will cause rents to rise faster. In turn, new development (or redevelopment) could occur more quickly than in the absence of transit, and/or the type of development could be affected. (For example, more people oriented uses, such as retail, high density residential or office buildings could be favored over other uses, such as warehousing.)

In most cases, the presence of a station would not dramatically affect station area real estate trends. It would take at least 9 years to plan and implement a transit system. During this time period, current planned development and redevelopment activities will be well advanced, and much of the vacant land in this corridor will largely be developed. Although identification of station area sites could influence real estate development in advance of system construction since land owners could anticipate transit benefits, the actual benefits from an operational transit system will occur too late to have a major impact on development. However, over time, rents and land values in station areas would be higher than for comparable areas located at a distance from station areas. The one exception would be if local governments intervened and required higher density uses around station areas. This could result in land-banking of these sites until the market could support higher density uses.

An assessment of station area development trends is useful in understanding the nature of transit impacts on station area development patterns. The first situation is one where there is either current development or redevelopment activity or where such activity is likely to occur within the next decade prior to the implementation of the project given the level of market demand. The Concord station area falls into this category. Development is occurring in this area without a BART or LRT extension; however, the presence of an existing BART station has been instrumental in encouraging development. This development should be completed within five to fifteen years, if market demand for office space increases again in the 1990's. A rail extension would help make these developments more successful. In turn, intensive development helps the transit system by increasing patronage. (In the case of a BART extension, impacts are less clear. Although downtown Concord would no longer be a terminus, patronage would increase from residents living in the east county.)

The Mt. Diablo station area is another example of an area where redevelopment may be completed by the time the system is operating. This area is already under development pressure from the hospital complex. Although the local market does not currently support high density residential development (City of Concord, April 1, 1985), it is likely that office development (on a small scale) will continue over the next fifteen years. An LRT station could benefit employees commuting to this hospital area and could possibly encourage higher density office development.

Station Area	System Alternatives	Existing Land Uses and Major Activity Centers	Future Development/ Redevelopment Plans	Transit Impacts on Future Development
Concord	4, 4A, 5, 6, 7, 7A, 7B and 8	Downtown activities, including office and commercial uses, Concord BART station and parking. Major office buildings include the Bank of America office complex and the two Concord Centre buildings. A residential area is adjacent as well.	Central Concord Redevelopment Plan applies to area. Plan regulates uses, setbacks, FAR's etc. Majority of new development is privately financed. A hotel is planned on BART-owned property in the near future.	Development may be completed by the time transit is operating. Transit could help its success.
Mt. Diablo	4, 4A and 5	Primary land use is residential. Other major land uses include medical offices, Mt. Diablo Hospital and School and Baldwin Park. This is the oldest neighborhood in the city.	Part of the area is included within the North Todos Specific Plan area. Purpose of Specific Plan is to allow for greater variety and more intense development, e.g., medical offices to serve hospital and increased residential densities, while still retaining existing single family character.	Transit could strengthen area as a medical and office center.
North Concord/ Martinez	4, 4A, 5, 6, 7, 7A, 7B, 8	Primarily residential to the south. The Concord Naval Weapons Station is located to the northeast. An industrial area is to the northwest, and a golf course is to the north.	A large auto-oriented discount retail store will be developed on vacant land to the northwest of station area.	Limited impact since much of the area is already developed as single family housing or is owned by the Navy.
West Pittsburg	4, 4A, 7, 7A, 7B, 8	Residential, some vacant land, mobile home park, and a school.	The area will experience continued residential development, since there is vacant land which is designated for residential use in the General Plan.	Limited impact unless future residential development would be of higher densities. Higher densities are not designated by the General Plan for this area, nor do they reflect current market trends.

BART AND LRT STATION AREA DEVELOPMENT TRENDS
AND POTENTIAL TRANSIT IMPACTS
(Continued on next page)

Table B.14

Station Area	System Alternatives	Existing Land Uses and Major Activity Centers	Future Development/ Redevelopment Plans	Transit Impacts on Future Development
West Pittsburg	5	Some residential and commercial uses, Shell Oil Company, other industrial uses, and vacant land (to the north of proposed station).	Vacant land is designated in the General Plan to be an industrial park area, with some multi-family residential areas and a shopping center at the corner of Willow Pass Road and Port Chicago Highway. Station is located within the West Pittsburg Redevelopment Project Area.	Transit could affect timing and type of new development.
Pittsburg	4, 4A, 7, 7B, 8	Existing land uses are mixed. To the north are located the Pittsburg city offices and other municipal buildings, including a high school. Other surrounding land uses include residential, commercial and some industrial. There are shopping centers about one mile south.	The area is located within the enterprise zone and the Los Medanos Community Development Plan area. One possible plan would be to relocate city offices north, to assist downtown revitalization.	Transit could affect development, particularly if city offices were relocated, and vacated land made available for development.
Alternative Pittsburg Location	4, 4A, 7, 7B, 8	Area overlaps with above station area. Additional uses to the East include warehouse, and residential land uses.	Station would be located further from the municipal buildings. It is located within the Enterprise Zone and the Los Medanos Community Development Plan area.	Similar to Pittsburg Station (above).
Pittsburg	5	Primarily residential and commercial, including warehouses. Some of the buildings are vacant. Area appears blighted.	Station is located near the southern boundary of the area included within the Downtown Specific Plan which aims to upgrade downtown area by improving infrastructure and buildings. A redevelopment area is located to the north of the station area. It is located within the Enterprise Zone and the Los Medanos Community Development Plan area.	If downtown area is publicly developed, then transit could strengthen these redevelopment activities. However, transit alone would be insufficient to cause private redevelopment, given weak market strength in area.

BART AND LRT STATION AREA DEVELOPMENT TRENDS
AND POTENTIAL TRANSIT IMPACTS
(Continued on next page)

Table B.14

Station Area	System Alternatives	Existing Land Uses and Major Activity Centers	Future Development/ Redevelopment Plans	Transit Impacts on Future Development
West Antioch	4, 4A, 7, 8	Existing land uses include Los Medanos Junior College, residential, commercial, and industrial uses (sand and gravel mining). Additionally, there is both vacant and agricultural land. Some of this land is designated as commercial and the rest is designated as manufacturing/ industrial. County East Mall is located further south of the station area.	A large shopping/office complex is under construction adjacent to station (between the SPTC tracks and Highway 4, west of Somersville Road). The area adjacent and south of Highway 4 is currently developing with retail and services uses. Station is located within the Los Medanos Community Development Plan area.	Transit will assist the success of the new shopping center. It could affect direction of development on vacant lands, if General Plan designations were changed to more intensive uses.
West Antioch	5	(This station area is discussed above under West Antioch above.)		
Antioch	5	Existing land use is primarily residential, with some commercial bordering "A" Street, and some industrial land adjacent to SPTC tracks.	Area is developed. No specific area or redevelopment plans apply to area.	Development impacts would be minimal, since area is already developed.
East Antioch	4, 5, 7	Existing land uses are residential, industrial and agricultural. There is an abundance of vacant land, more to the north of Highway 4.	Area to the south of Highway 4 is contained within the boundaries of the Southeast Antioch Specific Plan. The plan's purpose is to guide new development on vacant lands in area. Vacant land is zoned north of Highway 4 for industrial uses, and south of Highway 4 for commercial/office use. The station is located within Redevelopment Project Area No.3.	Transit could affect timing and type of new development.

Source: Recht Hausrath & Associates and Michael Brandman Associates

BART AND LRT STATION AREA DEVELOPMENT TRENDS
AND POTENTIAL TRANSIT IMPACTS

Table B.14

TABLE B.15

SUMMARY OF LRT AND BART IMPACTS ON STATION AREA DEVELOPMENT POTENTIAL

<u>Station Areas Where Development or Redevelopment Activities will be Completed by the Time Transit System is Operating</u>.

LRT (Alternatives 4, 4A and 5): Concord, Mt. Diablo

<u>Station Areas Where There is Vacant Land. Transit Could Affect Timing and Type of New Development</u>.

LRT (Alternative 4): same as BART alternative 7

LRT (Alternative 4A) West Pittsburg, Pittsburg, and West Antioch

LRT (Alternative 5): West Pittsburg, Pittsburg, West Antioch, and East Antioch

BART (Alternative 7): West Pittsburg, Pittsburg (both alternatives), West Antioch, East Antioch

BART (Alternative 7A): West Pittsburg

BART (Alternative 7B): West Pittsburg and Pittsburg (both alternatives)

BART/LRT (Alternative 8): same as LRT alternative 4A

<u>Station Areas Which are Surrounded by Existing Developments. Transit's Effect Would be Minimal in the Near Term</u>.

LRT (Alternative 5): Antioch

<u>Station Areas Located in Restricted Use Areas. Transit Would Have Little or No Impact</u>.

BART (Alternatives 6, 7, 7A, and 7B): North Concord/Martinez

LRT (Alternatives 4, 4A and 5): North Concord/Martinez

BART/LRT (Alternative 8): North Concord/Martinez

Source: Recht Hausrath & Associates 1988.

The next group of station areas are those which are surrounded by some vacant land, but which do not currently face strong demand for development. Some new developments may already be constructed, but vacant land remains. This is the case at the West Antioch station area. Market demand in these areas has not yet reached the level to justify the prices anticipated by land owners, and in some cases, to pay for land development costs as well. (Many of the vacant areas lack needed infrastructure.) At some time in the future - possibly before the transit system is operating - much of this land will be developed. The presence of a BART station in these areas could result in the land being developed more rapidly and more intensely, and perhaps favoring higher rent paying uses, such as R&D or office development over industrial development. The presence of an LRT station would affect development but to a lesser degree than BART, since LRT carries fewer patrons.

This situation described above prevails at the alternative BART and LRT station areas in West Pittsburg, Pittsburg, West Antioch, and East Antioch. There are differences among these four areas in terms of the strength of prevailing market demand and types of public policies guiding development. For example, market demand is weakest in West Pittsburg and strongest in West and East Antioch. The Pittsburg station areas potentially face the greatest influence from public policies since they are within the jurisdictions of two projects (Los Medanos Community Development Plan and the Enterprise Zone) intended to improve employment and development within a broad area of Pittsburg, particularly north of State Route 4. The creation of a BART station at Railroad Avenue in Pittsburg would strengthen future redevelopment activities. The LRT station at the SP tracks and Railroad Avenue would be located closer to the center of the older downtown area which is undergoing more intensive redevelopment. Consequently, it could have even more of a positive impact on downtown redevelopment activities, if traffic congestion did not become a problem. (Pride, 1987.)

The third group of stations are those which are surrounded by existing development. Only the Antioch LRT station falls into this category. Transit's effect would be minimal in the near term since land values are not high enough to justify private redevelopment of sites although in the long run, redevelopment could be feasible. Until there is market demand for land in these areas for the types of developments that pay higher rents, it is unlikely that LRT will have any redevelopment impacts.

The final group of station areas are those where transit-induced development impacts are unlikely, since these areas are not influenced by market forces. The North Concord/Martinez station is the only station falling into this cateogry. The proposed station is located on the boundary of the Concord Naval Weapons Station. In addition, north of State Route 4, there is a golf course. Unless land use radically changed in this area, it is unlikely that transit will lead to any development impacts, although workers at the Naval Weapons station would benefit from the proximity of transit at the North Concord/Martinez Station if shuttle service is provided.

Mitigation Measures

For those station areas where redevelopment planning and/or activities are underway, it is recommended that local agencies consider a more active role in land assembly, if it appears that without public intervention, redevelopment of station area sites would not be of the type or the densities that are compatible with transit.

Local governments may review general plan designations for the vacant lands surrounding station areas and consider requiring higher density uses around these stations, if encouragement of station area development is desired. Although this may result in delayed development, ultimately it will lead to efficient land utilization and increased system patronage.

B.2.4. IMPACTS ON REVENUES AND TAX BASE

Property taxes and sales taxes are the principal revenue sources which could be affected by improvements in the transportation system. Again, the rail alternatives - particularly BART - would have a greater impact on these revenues sources than would the non-rail alternatives, although impacts are limited in either case.

It is possible that property taxes would rise, since land could be more intensively developed adjacent to BART or LRT stations. For example, a developer could decide to construct office space adjacent to a transit station, whereas in the absence of the transit station, the market might support warehousing or some other light industrial use only. Since the office space is a higher value land use, there would be an increase in property tax revenues. (The non-rail alternatives do not generally lead to an intensification of development activities.)

In general, property tax values could rise in the Pittsburg-Antioch Corridor due to BART or LRT, since properties in the area could face higher demand. Higher values result in greater property tax revenues, although revenues lag behind price appreciation due to Proposition 13. In some cases, there is relocation of development activity within a city or region. So, although there is a shifting of the location of revenue growth, there is not an absolute increase. Another possibility is that land is developed faster because the rail system has improved accessibility. Again, in this case, there would not be a greater absolute growth over time, but in the short term (twenty years or less), there could be accelerated growth.

One exception to these two cases is the situation in which the presence of a transit station encouraged higher quality construction than would otherwise occur in the city or region. In this latter case, there would be a small, positive, net revenue impact.

Sales tax revenues would increase only minimally. Retailers may alter their locational decisions based on the presence of rapid transit. However, it is likely that the clustering of retail activities at a transit station is due to a relocation of area retailers, rather than due to an absolute growth in the number of establishments and associated sales.

Greater area retail growth could occur if the area became a regional, retail center, attracting consumers from outside the area. Given the retail opportunities that currently exist in Contra Costa County, it is not likely that any one or two transit stations could become a regional shopping center in the same way that downtown San Francisco currently is; the only exception could be the West Antioch BART Station. A retail center located at West Antioch, however, would not attract as many customers as other Contra Costa County retail centers do, such as downtown Walnut Creek or Sun Valley Shopping Center.

Another way in which net area sales could grow would be if the area experienced greater population growth that resulted in expanded taxable sales. Since it is assumed that the transit improvements would not increase regional population growth beyond that currently projected, this scenario is also not likely to occur. Consequently, it is more likely that there would be little net growth in taxable sales and associated sales tax revenues.

B.2.5 POTENTIAL FOR DERIVING TRANSIT REVENUES FROM VALUE CAPTURE

Transportation system improvements can also increase the value of land and properties. This value increase is most noticeable adjacent to station areas. The rail alternatives are much more likely to increase land and property values than Alternatives 1, 2, 3 or 3A. This value increase can sometimes provide an additional source of transit revenues, particularly to fund operations.

One source of station construction revenues could be a sharing in the tax increments already being collected by a redevelopment agency. If it can be demonstrated that property values adjacent to a station will increase at a faster rate due to the development of a LRT or BART station than they would in the absence of a station, then the transit operator could be in a good position to negotiate with the affected redevelopment agency to share in a percentage of the tax increments collected in the immediate area, since the redevelopment agency's tax revenues will be greater. There is a range of possible revenues that could be collected, depending on what percentage of the increment the redevelopment agency shares, the growth in the tax base due to the presence of a transit station, and the period of time during which increments would be shared.

There are also revenue sources for operations and maintenance. The first could be concessions operated at BART stations. These concessions are possible because retail and service demand is generated by BART patrons. Thus, again, concessions are examples of transit revenues made possible by an increase in value to the private sector. Five system alternatives include BART or a BART component which could provide space for concessions. Possible annual revenues in 1987 dollars from these alternatives can be projected based on current revenues provided by concessions at the Pleasant Hill BART station (an example of a through station) and the Concord Station (an example of a terminal station). These revenue projections are as follows:

Alternative 6:	$28,648 annually
Alternative 7:	$107,528 annually
Alternative 7A:	$48,368 annually
Alternative 7B:	$68,088 annually
Alternative 8:	$24,184 annually

A second source of revenues for operations and maintenance could be provided by joint development projects at BART stations, particularly at the Pittsburg, West Antioch and East Antioch Stations. These revenues would not be realized until after the year 2000, since local real estate market conditions would not support joint development projects until that time. Without projections of possible rents, it is not feasible to project potential revenues at this time.

B.2.6 EMPLOYMENT IMPACTS OF CONSTRUCTION AND OPERATION

The construction and operation of the rail alternatives would have a positive impact on the regional economy by creating more jobs. For a three to five year period in the 1990's, jobs would be generated on a temporary basis to construct needed facilities. On a continuing basis, jobs would also be created to operate the transit facilities once completed. Additionally, there would be a "multiplier effect" or indirect employment impacts, since newly employed workers would consume additional goods and services whose provision would generate additional employment. (Indirect employment effects could also be generated through expenditures on materials during system construction. Since a large percentage of these materials will come from outside the region, this contribution to indirect employment impacts is less important.)

Table B.16 presents direct and indirect employment impacts from both the construction and operation phases of project alternatives. These direct employment estimates were derived from projections of the construction and operations labor cost data for each alternative. The construction emloyment estimates cover the entire construction period, whereas the operations employment estimates are for the year 2000 only. The amount of employment that would be generated is directly related to the amount of expenditures and is calculated by dividing total labor costs by a worker's average, annual wage plus fringe benefits. (Different wage estimates were used for construction and operations.) Indirect employment estimates are also positively related to expenditures and are related to direct employment estimates through empirically validated multipliers that vary by employment sector.

As Table B.16 indicates, the more expensive alternatives will generate the greatest direct and indirect employment effects during the construction and operating periods. Direct construction employment impacts will vary from zero (Alternative 1 [no-build]) to 4,553, for Alternative 7 (BART to Antioch). In general, rail alternatives (either LRT or BART) that extend to the Cities of Pittsburg or Antioch will generate the most direct and indirect jobs, both during the construction and operation phases. Also, operation period employment is much less than construction employment, except for Alternative 2 (TSM).

Although employment requirements are high for many of the rail alternatives, they would not lead to significant impacts. Employment generation does not completely result in net, new job creation in Contra Costa County or in the larger San Francisco Bay region. Some workers may change from one job to another or may be under-employed and become fully employed. Consequently, the employment numbers presented in Table B.16 refer to direct and indirect employment generated by system construction and operation, not net job growth - which would be less. Since the San Francisco Bay Area encompasses a large labor market area, it is not anticipated that employment impacts would result in regional labor shortages or competition among related industries for skilled workers.

Alternative	CONSTRUCTION[1] Direct Employment	Indirect Employment Effect[3]	Total Employment (Direct and Indirect)	OPERATIONS[2] Direct Employment	Indirect Employment Effect[4]	Total Employment (Direct and Indirect)
1 No-Build	-0-	-0-	-0-	-0-	-0-	-0-
2 TSM	2	3	5	64	80	144
3 Busway/HOV to Antioch	1,589	2,288	3,877	87	109	196
3A Busway/HOV to Pittsburg	1,093	1,574	2,667	78	98	176
4 LRT to Antioch via State Rte. 4	3,340	4,810	8,150	259	324	583
4A LRT to W. Antioch via State Rte. 4	2,689	3,872	6,561	238	298	536
5 LRT to Antioch via State Rte. 4 and SPRR	3,310	4,766	8,076	274	342	616
6 BART to N. Concord	1,199	1,727	2,926	119	149	268
7 BART to Antioch	4,553	6,556	11,109	340	425	765
7A BART to W. Pittsburg	2,206	3,177	5,383	188	235	423
7B BART to Pittsburg	3,171	4,566	7,737	239	299	538
8 BART to N. Concord and LRT to W. Antioch via State Rte. 4	3,245	4,763	7,918	267	334	601

[1] Employment impacts are based on construction cost estimates. These costs primarily cover labor costs only. Where expenditures for vehicles, materials or right-of-way acquisition can be clearly identified, they have been excluded. Construction costs would be spread out over a period of three to five years. Employment figures refer to person years of employment.

[2] Employment impacts are based on operation and maintenance cost estimates for the year 2000. Employment figures refer to person years of employment.

[3] Employment estimates are calculated with an indirect employment multiplier of 1.44 based on an average of multipliers derived by ABAG for highway and public utilities construction sectors.

[4] Employment estimates are calculated with an indirect employment multiplier of 1.25 based on an average of multipliers derived by ABAG for Transportation Services sectors.

SOURCE: Recht Hausrath & Associates

EMPLOYMENT IMPACTS OF CONSTRUCTION AND ONGOING OPERATIONS

TABLE B.16

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Persons

Mike Adams, Research Analyst, California State Controller's Office, June 22, 1987.

Michael Borunda, Human Resources Department, City of Pittsburg, May 2, 1988.

Jeff Brotman, Analyst, MacMasters and Westland Realty, June 11, 1987, June 11, 1987.

Chuck Gabrysiak, Principal Planner, City of Concord, April 21, 1988.

David Golick, Planner, City of Concord Planning Department, April 13, 1988.

Randy Jerome, Planning Analyst, City of Pittsburg Planning Department, June 24, 1987.

Janet Linse, Planner, City of Concord Planning Department, July 17, 1987.

John McCallum, Planner, MTC, July 9, 1987.

Evelyn McGill, Research Analyst, California Employment Development Department, June 23, 1987.

Linda Molton, Cartographer, Contra Costa County Planning Department, June 12, 1987.

Kerry O'Banion, BART Joint Development, April 11, 1988.

Eric Parfrey, Senior Planner, Contra Costa County Planning Department, June 16, 1987.

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Jerry Raycraft, Contra Costa County Planning Department, May 11, 1988.

Martin Strauss, Planning Analyst, City of Pittsburg Planning Department, June 17, 1987.

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Appendix C
Cultural Resource Evaluation

CULTURAL RESOURCES EVALUATIONS FOR THE PITTSBURG-ANTIOCH ALTERNATIVES ANALYSIS CONTRA COSTA COUNTY, CALIFORNIA

Prepared for:

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San Francisco, California
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Prepared by:

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PREFACE

The cultural resources evaluation has been prepared in accordance with prevailing CEQA cultural resource management requirements and guidelines. In addition, the study follows the approach and depth of analysis appropriate for the transportation alternatives analysis per Section 106 of the National Historic Preservation Act.

CONTENTS

INTRODUCTION

The Pittsburg-Antioch Corridor is located in Contra Costa County, California and extends from the existing Bay Area Rapid Transit (BART) Station in Concord, north to the Highway 4 right-of-way and east through Pittsburg to Antioch (see Map 1).

In accordance with prevailing cultural resources management requirements and guidelines, historic and archaeological properties which may be affected by proposed transit projects must be evaluated in regard to significance, impacts and mitigation. Specifically, Section 106 of the National Historic Preservation Act requires that Federal agencies identify and assess the affects of expenditures of Federal funds on historic sites, districts and buildings and on archaeological sites.

Under Section 106 requirements, a thorough analysis of all resources will be required, including the determination of significance (as per National Register of Historic Places nomination criteria) of all historic and prehistoric resources. It is, however, noted in "Procedures and Technical Methods for Transit Project Planning" prepared by the Urban Mass Transportation Administration (UMTA -- Draft February 1986), that for alternative analysis studies, a complete cultural resources evaluation is probably not possible; "in effect, the purpose of the effort is to identify any likely problems in meeting the 4(f) and (Section) 106 requirements for each alternative....This general guideline provides substantial latitude for determining the level of effort" to be accomplished for alternative analysis studies.

UMTA guidelines limit this phase of the cultural resources work. Consequently, the alternatives analysis study tasks, while not complete, are believed to be well within the evaluation parameters as per the UMTA procedural guidelines. These tasks, which were developed in consultation with the State Historic Preservation Office in Sacramento, are as follows:

- Inventory the historic and archaeological properties located within the project area of potential environmental impact and conduct preliminary field surveys to assess the presence of previously unrecorded resources;

- Assess the potential impacts on resources that are listed on the National Register of Historic Places, as well as those properties that are potentially eligible for listing on the National Register; and

- Discuss mitigation/management alternatives for minimizing the potential impacts to significant resources and recommend additional studies required to complete Section 106 requirements.

PROJECT DESCRIPTION

The alternative for the Pittsburg-Antioch Corridor Study are:

. Alternative 1	No Build (Existing System and Programmed Improvements)
. Alternative 2	Transportation Systems Management (TSM)
. Alternative 3	Busway/High Occupancy Vehicle (HOV) Lanes to Antioch
. Alternative 3A	Busway/High Occupancy Vehicle (HOV) Lanes to Pittsburg
. Alternative 4	Light Rail Transit (LRT) to Antioch via Highway 4
. Alternative 4A	Light Rail Transit (LRT) to West Antioch via Highway 4
. Alternative 5	Light Rail Transit (LRT) to Antioch via Highway 4 and Southern Pacific Railroad
. Alternative 6	BART to North Concord/Martinez
. Alternative 7	BART to Antioch via Highway 4
. Alternative 7A	BART to West Pittsburg via Highway 4
. Alternative 7B	BART to Pittsburg via Highway 4
. Alternative 8	BART to North Concord/Martinez. Light Rail Transit (LRT) to West Antioch via Highway 4

Legend

- HOV LANE ALIGNMENT – ALTERNATIVE 3, 3A
- PORT CHICAGO HIGHWAY/ STATE ROUTE 4 ALIGNMENT – ALTERNATIVES 4, 4A, 6, 7, 7A, 7B, AND 8
- SOUTHERN PACIFIC TRANSPORTATION COMPANY ALIGNMENT – ALTERNATIVE 5
- STATION LOCATIONS
- EXISTING BART LINE
- (4) TERMINUS OF ALTERNATIVE

NOTE: (1) – NO BUILD
(2) – TSM

Transportation Alternatives
Pittsburg-Antioch Corridor
AA/DEIR

North

0 1.5 3 MILES

BART

MAP 1

Station locations are as follows:

Alternative 3

. West Pittsburg	At Bailey Road existing BART Park-and-Ride facility.
. Pittsburg	Park-and-Ride facility on north side of Highway 4, west side of Railroad Avenue.
. Pittsburg (Alternate Location)	Park-and-Ride facility on south side of Highway 4, between Railroad Avenue and Harbor Street.
. West Antioch	Park-and-Ride facility on north side of Highway 4, west of Somersville Road.
. East Antioch	At Hillcrest Avenue existing BART Park-and-Ride facility.

Alternative 3A

. Same as Alternative 3, less the West Antioch and East Antioch Stations.

Alternative 4

. Concord	North of Concord BART Station spanning Clayton Road.
. Mount Diablo Hospital	Port Chicago Highway median at Mount Diablo Hospital.
. North Concord/ Martinez	East Side of Port Chicago Highway at existing BART Park-and-Ride facility.
. West Pittsburg	Station in Highway 4 median just west of Bailey Road. Parking at existing BART Park-and-Ride facility.
. Pittsburg	Station in Highway 4 median just west of Railroad Avenue. Parking on north side of Highway 4, west side of Railroad Avenue.

- Pittsburg (Alternate Location) — Station in Highway 4 median between Railroad Avenue and Harbor Street. Parking south side of Highway 4, between Railroad Avenue and Harbor Street.

- West Antioch — Station in Highway 4 median between Standard Oil Avenue and Somersville Road. Parking on north side of Highway 4.

- East Antioch — On north side of Highway 4 at existing BART Hillcrest Avenue Park-and-Ride facility.

Alternative 4A

- Same as Alternative 4, less the East Antioch Station.

Alternative 5

. Concord	North of Concord BART Station spanning Clayton Road.
. Mount Diablo Hospital	Port Chicago Highway median at Mount Diablo.
. North Concord/ Martinez	East side of Port Chicago Highway at existing BART Park-and-Ride facility.
. West Pittsburg	West of Bailey Road/Willow Pass Road intersection on north side of Willow Pass Road.
. Pittsburg	Between Railroad Avenue and Harbor Street on south side of SPTC tracks. Parking on north side of SPTC tracks.
. West Antioch	West of Somersville Road on south side of SPTC tracks. Parking adjacent to station.
. Antioch	Between D Street and A Street on south side of SPTC tracks. Parking on north side of SPTC tracks.
. East Antioch	On the south side of the SPTC tracks at existing BART Hillcrest Avenue Park-and-Ride facility.

Alternative 6

. North Concord/ Martinez	East side of Port Chicago Highway at existing BART Park-and-Ride facility.

Alternative 7

.	North Concord/ Martinez	East side of Port Chicago Highway at existing BART Park-and-Ride facility
.	West Pittsburg	Station in Highway 4 median just west of Bailey Road. Parking at existing BART Park-and-Ride facility.
.	Pittsburg	Station in Highway 4 median just west of Railroad Avenue. Parking on north side of Highway 4, west side of Railroad Avenue.
.	Pittsburg (Alternate Location)	Station in Highway 4 median, between Railroad Avenue and Harbor Street. Parking south side of Highway 4, between Railroad Avenue and Harbor Street.
.	West Antioch	Station in Highway 4 median, between Standard Oil Avenue and Somersville Road. Parking on north side of Highway 4.
.	East Antioch	On north side of Highway 4 at existing BART Hillcrest Avenue Park-and-Ride facility.

Alternative 7A

. Same as Alternative 7, less the Pittsburg, West Antioch and East Antioch Stations.

Alternative 7B

. Same as Alternative 7, less the West Antioch and East Antioch Stations.

Alternative 8

. Same as Alternatives 4A and 6.

STUDY METHODS

The cultural resources studies for the Pittsburg-Antioch Corridor Alternatives Analysis was initiated by consulting with the State Historic Preservation Office (SHPO) for purposes of reviewing the study corridors and the criteria for determining the Area of Potential Environmental Impact (APEI). Archival review was then undertaken by Jack M. Miller, Jan M. Hupman and David Chavez and architectural historian Sally B. Woodbridge. This study phase consisted of reviewing existing materials that relate to prehistoric and historic resources and resource potentials within the project study area.

Archival research for prehistoric resources was initiated by reviewing in-house reports, records, maps and documents for Contra Costa County. A similar literature review was accomplished at the California Archaeological Inventory Northwest Information Center at Sonoma State University in Rohnert Park. The Native American Heritage Commission in Sacramento and the Native American Heritage Preservation Project in Contra Costa County in Richmond were also consulted.

The historic properties literature search included collecting information and pertinent documents from the appropriate city and county agencies as well as conducting personal and telephone interviews with individuals knowledgeable about the area's history and structures. The following publications were reviewed:

- The National Register of Historic Places, 1979 through 1986
- The California Inventory of Historic Resources, 1976
- The California Historical Landmarks Inventory, 1982
- Concord Historical Society Newsletter, Landmarks Edition, September 1986
- Preliminary Historic Resources Inventory, Contra Costa County, 1976
- Caltrans Historic Bridges Inventory, District 4, 1986

Agencies and individuals contacted are listed in the Appendix.

In addition, the potential for historic structural and archaeological resources was investigated by reviewing maps and documents at the Bancroft Map Library, University of California, Berkeley; the California Historical Society Library, San Francisco; and the California History Room, Public Library Main Branch, San Francisco.

The following pertinent documents were reviewed:

- Sanborn Insurance Maps for Concord, Pittsburg and Antioch (see references for specific years)
- Official Map of Contra Costa County, California, compiled from private surveys and official records by T. A. McMahon, 1908
- Topographic Map of Contra Costa County, compiled for the Board of Supervisors from the State Geological and United States Surveys, 1871

An historic properties and archaeological field review was then undertaken. The APEI was delineated by reviewing the Project Plan and Profile Drawings and consulting with SHPO. It is assumed that the APEI for Alternatives 1, 2, 3 and 3A will eventually be determined by the California Department of Transportation (Caltrans) and the Federal Highway Administration (FHWA); for this alternatives analysis we assume that the APEI for those four alternatives will be confined to the existing Highway 242, Highway 4 and Concord Avenue right-of-ways. The APEI for Alternatives 4 and 4A has a maximum width of 130 feet where the Light Rail Transit (LRT) corridor parallels Port Chicago Highway and where the LRT corridor is located in the Highway 4 median. The alignment from the Concord BART Station to Highway 4 parallels the east side of port Chicago Highway with a maximum offset of 65 feet from the roadway median. The Alternative 5 APEI is the same as Alternative 4 up to the Highway 4-Willow Pass Road intersection where the LRT alignment proceeds north to the Southern Pacific Railroad (SPRR) right-of-way. The LRT APEI then has a maximum width of 125 feet, which generally corresponds to the SPRR right-of-way. The Alternative 6 APEI has a maximum width of 120 feet along the Port Chicago Highway from the Concord BART Station to Highway 4. The BART alignment parallels the east side of the roadway with a maximum off-set of 70 feet from the median. The APEI for Alternatives 7, 7A and 7B is basically the same as Alternative 4. The

numerous station locations and parking areas vary in size, however, their boundaries are clearly delineated on the Plan and Profile Drawings and those boundaries are assumed to be the APEI for those facilities. The APEI for Alternative 8 is the same as for Alternatives 4A and 6.

The historic properties survey was conducted by Sally B. Woodbridge. The review was initiated by driving and viewing all of the study corridors and then walking selected areas where the greatest historic properties sensitivities were apparent. The downtown Concord historic district surrounding Todos Santos Plaza was surveyed; this included the area generally bordered by Almond Avenue, Port Chicago Highway-East Street, Clayton Road and Galindo Street. Particular emphasis was placed on the area adjacent to Port Chicago Highway and the Concord Avenue connector between the BART station and Highway 242. In Pittsburg the historic area, bound by Third Street, Los Medanos Street, Diamond Street and Eighth Street, was reviewed. Particular attention was given to the southern extension of the historic area at the Railroad Avenue intersection with the SPRR line.

Historic properties that were found to be in or adjacent to the study corridors are discussed in the following historic setting section.

The archaeological field review was accomplished by David Chavez and Jan M. Hupman. The survey was initiated by driving and viewing all the study corridors. Areas for survey were selected based on the general environmental circumstances that favor the occurrence of prehistoric sites and the accessibility of those locations. The survey areas, which are shown on Maps 2 through 7, are as follows:

- Port Chicago Highway -- The majority of the terrain in this corridor, between the Concord BART Station and Highway 4, was surveyed. A bicycle path extends along the old railroad grade on the east side of the roadway and field inspection was concentrated in that area. Some portions of open terrain were also surveyed on the west side of the roadway.

- Highway 4 -- Field review of this corridor was limited to the survey of small accessible segments of terrain adjacent to the following waterways: Lawlor Ravine Creek, Kirker Creek and two unnamed drainages in the West Pittsburg area located between Lawlor Ravine and Railroad Avenue. The West Pittsburg station and parking site at Bailey Road, the Pittsburg station and parking site at Harbor Street and the East Antioch station, yard and parking site at Hillcrest Avenue, were also surveyed.

- Southern Pacific Railroad -- Field survey along this corridor was conducted on both sides of the railroad grade, between North Broadway and Mallard Slough Road and between Willow Pass Road and Andrew Avenue in West Pittsburg; between Railroad Avenue and Standard Oil Avenue in Pittsburg; and between Cavallo Road and the East Antioch station and parking site at Hillcrest Avenue. Also surveyed was the Pittsburg station and parking site on Railroad Avenue.

The field survey of these areas can be described as a General Surface Reconnaissance (King, Moratto and Leonard 1973).

During the survey, close attention was given to the detection of those surface features that imply the presence of prehistoric cultural resources in this part of Contra Costa County (changes in soil color, composition and/or texture, which suggest the occurrence of archaeological midden; unusual ground contours or abrupt changes in vegetation patterns; the presence of prehistoric stone, shell or bone artifacts; obsidian, chert or other types of lithic flaking wastes; fire-fractured rock, charcoal deposits and/or charred faunal remains). Also, efforts were made to detect the presence of historic archaeological features and deposits.

Survey conditions were generally good in all the inspected areas. Selecting areas with good ground exposure was part of our sample survey strategy.

No prehistoric or historic archaeological sites were discovered as a result of the field investigation.

CULTURAL RESOURCES SETTING

PREHISTORIC SETTING

Contra Costa County prehistory has been defined by major archaeological investigations which have concentrated in the western and interior valley reaches of the County. Few such studies have occurred in northern Contra Costa County; however, because of the proximity of those locations to the study corridor and similarity in environmental settings, it is possible to relate the known regional prehistory to the study area.

Based on several archaeological investigations that have taken place in the interior valley (Walnut Creek to San Ramon Valley), seven different prehistoric cultural components have been identified for that region. These components range in time and cultural affiliation from early "Middle Horizon" to "Late Horizon, Phase 2" and represent a period from approximately 2500 B.C. to A.D. 1700 (Fredrickson, 1964, 1965, 1966, 1968, 1969; Mead and Moss 1967-cited in Moratto 1984:261). Based on geographic distribution of radiocarbon dates for one of the early cultural components (Berkeley Pattern), it appears that pre-Bay Miwok peoples (identified as Utian- speaking populations) moved into the Contra Costa region from the lower Sacramento Valley at approximately 2500 to 2000 B.C. (Moratto 1984:279). The prehistory of the area culminated with the presence of Bay Miwok tribal communities in the interior and northern parts of the County and Costanoan groups in the western and southeastern reaches of the County.

Concord

The general Concord area has an abundance of drainage systems -- Walnut, Mount Diablo, Galinda, Pine, Pacheco and Grayson Creeks -- that present potentially favorable settings for the location of prehistoric archaeological resources. Consequently, several sites are situated within the region, most of which are located at sufficient distances from the study area so as not to be directly affected by the project. Two such resources (CA-CCo-19 and -250) are, however, located relatively close to the study area and are of particular importance to these evaluations as they suggest the potential for

the presence of similarly important subsurface archaeological deposits in the study area. The nature and locations of these two sites were recently reviewed by Basin Research Associates (1983), and they are described as follows.

CA-CCo-19 is located immediately west of the Loma Vista School and the existing BART right-of-way, approximately 0.5 kilometers southwest of the Concord BART Station. The site was first recorded in 1955; in 1956, bulldozing in the area exposed prehistoric burials, which were investigated by A. Pilling and J. Bennyhoff from the Archaeological Survey at the University of California, Berkeley. During their investigations Pilling and Bennyhoff excavated five prehistoric burials that were situated in close proximity to one another and discovered the remains of at least seven other individuals in disturbed strata. Very little in the nature of diagnostic artifacts was discovered at that time and it has been concluded that CA-CCo-19 is a prehistoric site of unknown age and unknown areal extent. As far as can be determined, at least a portion of the site has been disturbed. Since the subsurface boundaries of this site remain unknown, the area immediately around the site and its general vicinity remain archaeologically sensitive (Basin Research Associates 1983:6).

CA-CCo-250 is located north of Willow Pass Road, approximately 1 kilometer east of Port Chicago Highway and approximately 1.5 kilometers northeast of the Concord BART Station. The site was originally recorded by N.C. Nelson in 1909 during his survey of San Francisco Bay region shellmounds. Also known as the Maltby Site, CA-CCo-250 was initially investigated in 1937 when nine prehistoric burials were excavated by a local amateur archaeologist. The site was reported to the University of California, Berkeley and a field party, which included R.F. Heizer, excavated twelve additional burials. Along with the burials, the site yielded a wide array of prehistoric artifacts including projectile points, Haliotis (abalone) ornaments, steatite earplugs and pipes, labrets, birdbone beads and whistles, stone pendants, mortars and pestles, bone awls, antler wedges, plummets and polished animal bone tubes with cut and polished ends. The site has been assigned to the early "Phase I of the Late Horizon," approximately A.D. 300 to 700. It is, however, very likely that the site was used into historic times as indicated by

discussions in the following ethnographic setting section. Although it has been concluded that the site has probably been destroyed (Lillard, Heizer and Fenenga 1939:61-cited in Basin Research Associates 1983:7), it is highly possible that additional cultural deposits are still present at the site location, particularly in the form of Native American burials. Therefore, CA-CCo-250 should continue to be regarded as a potentially significant cultural resource.

Neither CA-CCo-19 nor CA-CCo-250 are located within the Area of Potential Environmental Impact. However, the presence of these two prehistoric sites, with such culturally sensitive deposits, suggests a heavy occupation of the Concord environs during prehistoric times and, in the case of CA-CCo-250, early historic times. The general area must, therefore, be regarded as archaeologically sensitive, with a good potential for containing additional sites that may currently be obscured by existing ground cover.

Pittsburg-Antioch

Current records and maps show that no known prehistoric sites are located within or immediately adjacent to Highway 4 or the SPRR line. No archaeological resources are documented for the general Pittsburg area and there are only three recorded sites in the Antioch area, the closest of which is 1.5 kilometers north of the SPRR line. It is noted that very few comprehensive archaeological surveys have been accomplished in the general study area, particularly in and around the study corridors -- a circumstance which partially accounts for the lack of documented archaeological sites in the region. Another factor is that the Highway 4 and SPRR setting is characterized by environmental circumstances only moderately conducive to the potential occurrence of prehistoric archaeological resources. The region consists mostly of exposed, windblown terrain, with Willow Pass and its frequently steep hillsides the most prominent environmental feature. Some drainages are crossed by both Highway 4 and SPRR line and the more level terrain adjacent to those features are the most likely locations for discovering archaeological resources.

ETHNOHISTORIC SETTING

At the time of European contact, the Bay Miwok Indians occupied the eastern portions of present-day Contra Costa County, extending from Walnut Creek eastward to the Sacramento-San Joaquin Delta (Bennyhoff 1977:164; Levy 1978:398). According to a recent study of the region, the study area passes through the ethnographically identified "Chupcan" tribal territories (Milliken 1982:Map 2).

Anthropological sources suggest that Bay Miwok settlement and subsistence practices were oriented to major as well as intermittent watercourses. The Bay Miwoks made their living through the harvesting of wild plant foods, augmented with hunting and fishing. Acorns were a principal food source as well as various grass seeds and buckeyes. The settlement system of the Bay Miwoks was characterized by principal villages on terraced areas adjacent to watercourses. Seasonal dispersement took place for plant collection, hunting and fishing. Villages consisted of clusters of semi-subterranean, round to oval single- or multi-family dwellings. Larger structures of this kind, which were twelve to twenty feet is diameter and housed ten to twenty people, were still in use in the Concord area as late as 1852 (Loud 1913-cited in Milliken 1982:4).

Little ethnographic information on Bay Miwok technology is available; however, archaeological evidence indicates that the mortar and pestle were the dominant grinding tools. Other stone tools include hammerstones and choppers. Projectile points and knives were commonly made from locally available chert and imported obsidian. Bone awls were important for basket manufacturing. Trade with neighboring groups and excursions into neighboring territories was a common practice. For detailed discussions regarding Bay Miwok culture, subsistence practices, social and political organization and religion, reference is given to Kroeber (1925), Levy (1978), Bennyhoff (1977) and Milliken (1982).

The Bay Miwok were first contacted by Spanish exploring expeditions to the Sacramento-San Joaquin Valley in the second half of the eighteenth century. With the depletion of coastal area populations, the missionaries turned their

attention to the Plains Miwok, the Valley Yokuts and the Bay Miwok. The first "Chupcan" Indians were recorded at Mission San Francisco in 1794. Resistance to the missionization was fierce and continued into the 1810s when the Spanish constructed Mission San Jose and pressed the systematic round-up of East Bay tribes. The majority of Bay Miwok were taken to San Jose where the last baptismal recording was in 1827. During that period, many Bay Miwok disappeared through the combined efforts of forced removal to the missions and epidemics, which killed many thousands of peoples in the region (Levy 1978:400; Milliken 1982:15-16).

During the period of Spanish rule, it was assumed that the missions would "civilize" the Indians who would eventually return to their homelands as Christian farmers. The church was supposedly the ward of these people and the trustee of their land. However, there was pressure from the onset by ex-soldiers for "concessions of use" for the lands held in trust by the Spanish crown. Continued pressure grew with the consolidation of the independent Mexican government and in 1824 and 1827 laws were enacted that passed the lands from the mission trust to secular ownership. All lands previously held by the missions were to be passed into the hands of the mission Indian people, while all "unused" areas could be claimed as Mexican ranch lands (Milliken 1982:23).

The secularization law opened the way for a major land grab by Mexican ranchers at the expense of the missionized Indians. Government administrators at one mission after another reported that the Indian peoples had all died away. By the time the missions were completely shut down as landholding institutions, between 1834 and 1836, most of Contra Costa County was being carved into land grants.

It was within this context that Ygnacio Pacheco petitioned for Rancho Monte del Diablo, which included vast portions of what were once "Chupcan" tribal territories. Without an understanding of the legal situation and without political or military power, the surviving Mission San Jose "Chupcan" people lost the lands that were traditionally and legally theirs and probably ended up working for Pacheco at Rancho Monte del Diablo (Milliken 1982:23).

The end of the Bay Miwok culture came with the onset of the American era in 1849. Prior to that period, the Mexican land owners had considered the Indian workers to be an integral part of their ranching operations; after having taken their land, they had allowed the Indians to return to traditional village locations and live there while working on the ranchos. After 1849, American land owners began to dominate the region and they were inclined to drive the Bay Miwok people off their lands and eventually out of the region. Thus, the Bay Miwok, as well as other Native American tribal groups, lost contact with the last vestiges of their traditional way-of-life. Documentation of the Bay Miwok presence in the area from the 1850s on is limited to occasional recollections like the following gathered by L. L. Loud in 1913 from an American farmer.

> Nelsons 250 -- Mound 1.5 miles NW of Concord on west side of SPRR at edge of a brackish marsh, 3.5 miles from the open water of Suisun Bay. Mound formerly called "Mount Diablo" because so many Indians died and were buried there, hence the name Mountain of the Devil. The name was later shifted to what was later Mt. Diablo, which was first called Monte Cerro.
>
> Population. Band of 40 to 50 Indians living on mound in 1850. They worked for Galindo and Salvio Pacheco, two Spaniards who settled around it. The informant, C. B. Nottingham, who settled 2.5 miles north of Walnut Creek in 1852 says there was an epidemic in 1853, and states "I saw about nine dead there at one time. I think most of the band died off at that time." He saw the survivors off and on for ten years, and saw an old man and woman (of that group) in Clayton a few years ago. Faint recollection that their name was Soto.
>
> Houses. Dug hole three feet into side of mound, willow poles bent across to form half circle, covered with Tule mats, loose tule or grass, and daubed with mud (Loud 1913-cited in Milliken 1982:25).

Several anthropologists interviewed Indian people throughout the Bay Area during the early twentieth century. None of the people with whom they talked were from central or eastern Contra Costa County, nor did they provide any specific information about either the pre-Hispanic people of the area or their descendants (Milliken 1982:25).

Major ethnographically and archaeologically identified Bay Miwok villages are located in central and eastern Contra Costa County. No identified resources

of this nature are located within the project study corridors or in the immediate vicinity of those alignments. The nearest documented Native American resource is the Chupcan Village Site, CA-CCo-250 (also known as the Maltby Site and the Mount Diablo Site), which is located approximately 1 kilometer east of the Port Chicago Highway Study Corridor. This site should be regarded as a potentially significant cultural resource; archaeologically it appears to have been occupied at least as early as A.D. 300 and apparently was inhabited by Bay Miwok into historical times.

HISTORIC SETTING

The project study area experienced most of its existing development in the post-World War II decades. The pattern of residential development began modestly in the 1950s in the Concord area and steadily accelerated to the point of saturation. Another populated area, extending from West Pittsburg to Antioch, also experienced intensive construction activity in the form of residential tracts and related commercial projects. The area between Concord and Pittsburg-Antioch has always been undeveloped and consequently has few if any historically important structures. Portions of this area (where Highway 4 traverses the Naval Weapons Station in Concord) have been restricted to military use for decades, and no historically important structures or features are believed to be located in the immediate vicinity of Highway 4.

We have identified twelve historically important buildings within the study area. Three are located in one block adjacent to the Southern Pacific Railroad tracks in Pittsburg and are discussed in detail in the section on the historic development of Pittsburg. The other nine are located immediately east of Port Chicago Highway in a Concord residential neighborhood, developed in the decades from circa 1880 to 1930.

The study area encompasses a portion of northeastern Contra Costa County which, because of its geography, has two reasonably distinct areas with different patterns of settlement. The range of hills separating Concord from Pittsburg and Antioch form a natural barrier separating the valley, in which Concord is located, from the area to the east along the waterfront of the

Sacramento and San Joaquin Rivers, where Pittsburg and Antioch are located. This barrier is reinforced by the presence of the Naval Weapons Station, which stretches about 5 miles southeast and about a mile northwest of Highway 4. The land around Willow Pass Summit on Highway 4 is largely unoccupied and has probably changed little since the ranching era, which began in the early nineteenth century and lasted into the twentieth century.

Though all of Contra Costa County was divided into ranches during the Mexican Colonial Period (1822 to 1846), Concord did not participate in the industrial boom which resulted from the discovery of coal near Mount Diablo in the mid-nineteenth century. The mining-related shipping industries that fueled the development of Pittsburg and Antioch as water-oriented manufacturing centers was a logical result of their location between the Black Diamond mining area and the system of waterways extending from Suisun Bay to the Sacramento Rivers and its delta and the mouth of the San Joaquin River. Concord continued in ranching and agricultural development until the post-World War II Period when the exodus to the suburbs from the San Francisco Bay-side cities began. This suburban development has intensified and now includes office as well as residential development. The strong development activity around downtown Concord has brought about the demolition of most of the historical buildings that formerly gave a nineteenth-century character to the part of downtown located around the Todos Santos Plaza. A few buildings remain, however, and the Plaza itself provides a spacious and verdant link to the past. A more detailed description of the historical resources of this district follows in the section of historic Concord.

Although manufacturing has declined and suburban residential development has increased in the Pittsburg-Antioch area, such development has lagged behind that of Concord. The time lag and the direction of development away from the historic central business districts in Pittsburg and Antioch have resulted in the preservation of more of the historical building fabric there than in Concord. Still, for the most part, Highway 4 and the SPRR line run through areas characterized by more recent development.

The historical resources we have identified are confined to the area around the historic centers of Concord and Pittsburg. Because the historical

development of these two centers of population is dissimilar, it is appropriate to discuss them separately.

Concord

The Concord BART Station is located four blocks southeast of Todos Santos Plaza, the center of a twenty-block town established in 1876 when Luis Castro surveyed twenty acres of land for Don Salvio Pacheco, his son Fernando and son-in-law Francisco Galindo. The town founders intended to replace an older settlement named Pacheco, which was located between two creeks and was often flooded. Thus, Todos Santos was established and was incorporated as Concord in 1905 (Andrews 1986).

Two major landmarks associated with the town's founding families, the Pachecos and the Galindos, are located in the general vicinity of the study corridor. The first, the Don Fernando Pacheco Adobe, is a National Register of Historic Places property (6/6/80) and a State Historic Landmark (No. 455). Located at 3119 Grant Street, approximately 0.25 mile west of Highway 242, the building was restored in 1979 and is in use by the Horseman's Association. The second landmark is the Francisco Galindo house at 1721 Amador Avenue, which is location south of the Plaza and approximately 750 feet south of Concord Avenue. Built in 1856, the wood-frame house was enlarged and remodeled in the 1880s by Francisco's son John. The house remains in family ownership; the land around it, originally part of the grounds, is under study as an historic district by the City of Concord and the Concord Historical Society.

The major historic resource in the immediate vicinity of Todos Santos Plaza is the Salvio Pacheco Adobe of 1853 (State Historic Landmark No. 515). The land for the town of Todos Santos was originally associated with this Pacheco adobe. Within a block of the plaza is another landmark, the Foskett and Elworthy Building (the First National Bank), 1911-1912. Both of these historic properties have been restored and are in use. Highway 242 is located northwest of historic Todos Santos District, however, the Concord Avenue Connector from the BART station to Highway 242 extends through the southwest portion of the historic area. The Salvio Pacheco Adobe and

the Foskett and Elworthy Building are located adjacent to the Concord Avenue Connector, as are two other historic landmarks: the Concord Fire Hall and the Perry House, both located on Concord Avenue.

Port Chicago Highway runs from the Concord BART Station north along an old railroad right-of-way, which borders the east side of the historic Todos Santos District. North of the Plaza, for three blocks between Salvio and Almond Streets, East Street runs a block away from Port Chicago Highway. The street was once lined with residences dating from the late nineteenth century to the 1910s and 1920s. The city of Concord has designated three houses on East Street, around its intersection with Pacheco Street, as historic landmarks. They are the Elworthy house at 2118 East Street, the Barnett house at 2080 East Street and the Malty-McKinnon house, which was moved from its original location to 2099 East Street. Three other houses, which are also within a block of Port Chicago Highway, have been proposed for Concord Historical Landmark designation and will be reviewed by the city of Concord in the fall of 1987. These are the McKenzie-Collins house at 2460 Pacheco Street, the Rogers house at 2480 Pacheco Street and the Ginnochio house at 2459 Pacheco Street.

Other houses, fifty years old or more, are scattered throughout the blocks between East Street and Todos Santos Plaza. Although these are relatively modest dwellings, their location on the original 1876 town grid contributes to a feeling of continuity with the past, which is now absent from most of Concord. Historical landmarks associated with the Concord town center are shown on Map 8.

Port Chicago Highway, north from Almond Avenue to Highway 4, is lined with mostly modern residential development, much of which is separated from the corridor by high walls. The area appears to have been solidly developed in the post-World War II decades and has no apparent historical resources.

Pittsburg

Originally called "New York of the Pacific," Pittsburg was first platted in the decade following the 1849 Gold Rush by Colonel Jonathan D. Stevenson. Colonel Stevenson brought the First Regiment of New York Volunteers to California by sea, arriving in three ships in March 1847 to assist with the American occupation. Having decided to settle in California, Stevenson bought the Rancho Los Medanos in 1849 from the original Mexican grantees, Jose Antonio Mesa and Jose Miguel Garcia. The Colonel's ambitious plans for the seaport town included its becoming the State Capital. This scheme was unsuccessful, but with the discovery of coal in the Black Diamond mines to the south, Pittsburg boomed as a port (Hoover, Rensch and Rensch 1966:64).

The town was then called Black Diamond and the boom lasted into the 1880s. However, the coal was of poor quality and the town did not gain importance until later when it became a manufacturing center. Renamed Pittsburg in 1911, the town acquired a solidly-built central business district near the waterfront (Hoover, Rensch and Rensch 1966:64).

This district declined gradually and was almost abandoned by business interests beginning in the 1960s. Now in the 1980s, as part of the Pittsburg redevelopment area, its buildings are slated for rehabilitation. With the exception of three historic resources, historic Pittsburg is located several blocks north of the SPRR line.

On the northeast corner of the intersection of Railroad Avenue with the SPRR line, stands a circa 1878 Southern Pacific Railroad passenger and freight station which is now closed. Southern Pacific has offered to sell this station to local preservationists associated with the Pittsburg Historical Society. The purchasers will gain title to the building in January of 1988, but not to the land on which its stands (Aiello 1987). The Southern Pacific Station is potentially an historically significant resource both because of its age and its association with the nineteenth-century pattern of railroading in California.

Next to and immediately north of the Southern Pacific Station, and also fronting on Railroad Avenue, is a two-story, wood-frame commercial building that appears to date from the period of the Station and may represent the kind of commercial development that typically occurred near railroad depots to serve the needs of passengers. Although the history of the building's use is not clear, architecturally it appears to be representative of a recognized nineteenth-century building type. This structure is also potentially a significant resource.

At the northern end of the block, on the southeast corner of the intersection of Central Avenue with Railroad Avenue, stands the California Theatre, a circa 1930 movie house with tiled walls and a typical raised corner element with scalloped edges. The building's style is representative of both large city and small town Depression-era movie houses once present throughout the State. Such movie theaters have been increasingly viewed as historically significant, as their numbers have decreased in recent years.

Aside from the above mentioned three buildings, there are no other significant historical resources found in the northeastern part of the study area. In West Pittsburg and Antioch, Highway 4 and the SPRR line run through areas that have been built up in recent decades. Although Antioch has an historic center near the waterfront, it is relatively far from the SPRR and Highway 4 alignments.

The historic central districts found in Concord, Pittsburg and Antioch raise a concern for potential historic archaeological deposits in relation to the project study corridor. The Todos Santos Plaza historic district in Concord, which is generally defined by Almond Avenue, East Street, Clayton Road and Galindo Street, is considered to be highly sensitive regarding the potential presence of historic archaeological deposits and features. The Sanborn Insurance Maps for Concord show an abundance of dwellings, outbuildings, wells and other features from as early as 1891 within the historic area. The Concord Avenue Connector from the BART station to Highway 242 passes through the archaeologically sensitive zone. Port Chicago Highway is located to the east of the historic district, as the district is identifiable from the 1891 Sanborn Maps. The area east of East Street is identified as

agricultural fields and remains so designated on subsequent Sanborn Maps up to 1917, at which time the Southern Pacific Railroad grade is shown. Housing development around the corridor took place in the later decades and it is therefore concluded that historic archaeological sensitivity for Port Chicago Highway is relatively low.

Between Concord and the Pittsburg-Antioch region, very little in the way of historic features are shown on early County maps. The 1871 Contra Costa County Map shows three major property owners by the names of Kelleher, Murphy and Samuels northeast of Concord, halfway between the Pacheco and Galindo Adobes and Mount Diablo Creek. The map shows several structures on each of these properties, which are located in the general region of Highway 4; however, no specific historic archaeological sensitivity can be identified.

The Sanborn Maps for Pittsburg (1911 and 1917) show that the historic development of that town was primarily concentrated north of Eighth Street, several blocks away from the SPRR line and a good distance from Highway 4. The historically important SP Station building and adjacent structure are shown on the Sanborn Maps and it is believed that the area around the buildings is archaeologically sensitive.

The Antioch Sanborn Maps, beginning in 1884, show that the historic development was concentrated at a good distance north of the SPRR line and Highway 4 until 1926. The 1926 Sanborn Maps show a railroad station at the intersection of A Street and the SPRR line at the Antioch station and parking site. The historic station is no longer present on the site and modern buildings obscure the area; however; moderate historic archaeological sensitivity is assumed for that location.

SUMMARY OF PROJECT CORRIDOR RESOURCES

Two known archaeological resources are located within the vicinity of the study corridor.

- CA-CCo-19 is located approximately 500 feet southwest of the Concord Avenue Connector APEI, between the Concord BART Station and Highway 242 (see Map 2). The site is reported to be of unknown age and areal extent. A portion of the site has reportedly been disturbed, however it is possible that prehistoric cultural deposits, with good depositional integrity, are still present. Such deposits would likely yield information important to the study of Contra Costa County prehistory. The site is therefore considered to be a potentially significant archaeological site.

- CA-CCo-250 is located approximately 0.5 miles east of the Port Chicago Highway APEI (see Map 2). Despite the fact that the site has been greatly disturbed it is possible that additional cultural deposits are still present, particularly in the form of prehistoric and early historic period Native American burials. Deposits of this nature are of great cultural significance, particularly to the Native American community. Also, previous studies of the site resulted in a high yield of artifacts; if similarly abundant caches of artifacts are still present, such materials would be very valuable to local and regional archaeological studies. CA-CCo-250 is, therefore, regarded as a potentially significant cultural resource.

The distances of these two resources from the APEI indicate that they will not be affected by the project. Their importance is in their proximity to the study corridor and the implied potential for similar subsurface sites in the area.

Nine historic properties in the Concord area are located relatively close to the project APEI and three properties in the Pittsburg area are located in the APEI. All are considered to be historically significant by local planning agencies and historical preservation groups. The present level of research for most of the buildings does not permit a complete evaluation of their eligibility for listing on the National Register of Historic Places. However, their status in the communities warrants future consideration of National Register eligibility.

The following listing summarizes the historic architectural resources near the corridor alignments.

Concord

- Salvio Pacheco Adobe, 1870 Adobe Street. Built by the founding family of Concord in the Mexican Colonial Period, the significance of this building has been recognized by its designation as a State Historic Landmark (No. 515) and is likely eligible for listing on the National Register. The structure is located at least 150 feet southwest of the Concord Avenue Connector APEI.

- Concord Fire Hall, 982 Concord Avenue. This late Italianate-style firehouse of circa 1890 is a Concord Historic Landmark. While architecturally distinctive, the building would not be eligible for the National Register because it has been moved from its original site. The structure is located on the southwest side of Concord Avenue, approximately 25 feet from the connector APEI.

- Perry House, 1990 Concord Avenue. A 1911 Prairie-style house recognized as a Concord Historic Landmark, but not eligible for the National Register because it has been moved from its original site. The structure is located on the southwest side of Concord Avenue, approximately 25 feet from the connector APEI.

- Foskett and Elworthy Building, 2001 Salvio Street. A 1911-1912 Mission Revival-style commercial building recognized as a Concord Historic Landmark. The building has been refurbished, but would appear to have sufficient architectural integrity in addition to its historical significance to render it eligible for listing on the National Register. Further research would be required. The structure is located 50 to 75 feet east of the Concord Avenue Connector APEI.

- Francisco Galindo House, 1721 Amador Avenue. Built in 1856 by Francisco Galindo in a late Federal style and enlarged in the 1880s in the Eastlake mode, this is one of Concord's most significant buildings, both

architecturally and historically. It has been designated a Concord Historic Landmark and may be eligible for listing on the National Register. The structure is located at least 150 feet southwest of the Concord Avenue Connector APEI.

- Elworthy House, 2118 East Street. A circa 1910 Prairie-style house that belonged to a former Concord Mayor, the house has been designated a Concord Historic Landmark and is currently being renovated. Further research is needed to determine if it is eligible for listing on the National Register. The structure is located approximately 500 feet west of the Port Chicago Highway APEI.

- Barnett House, 2080 East Street. Another circa 1910 Prairie-style house, also designated a Concord Historic Landmark. Further research would be needed to determine whether its architectural and historical significance is sufficient to make it eligible for listing on the National Register. The structure is located approximately 500 feet west of the Port Chicago Highway APEI.

- Malty-McKinnon House, 2099 East Street. A Colonial Revival house, circa 1900. The building has been designated a Concord Historic Landmark, but would not be eligible for listing on the National Register because it has been moved from its original site. The structure is located approximately 600 feet west of the Port Chicago APEI.

- Don Fernando Pacheco Adobe, 3119 Grant Avenue. The significance of this building has been recognized by its listing on the National Register (6/6/80) and its designation as a State Historic Landmark (No. 455). The structure is located approximately 0.25 mile west of the Highway 242 APEI.

The locations of these structures are depicted on Map 8.

It is noted that the historic nature of the three structures located on Pacheco Street, to the west of Port Chicago Highway in Concord (the McKenzie-Collins house, the Rogers house and the Ginnochio house), is

unclear and research is required to determine if they are eligible for listing as Concord Historic Landmarks; their status as potential National Register properties is even more uncertain. These properties are not included in the resource inventory at this time; however, depending on pending city of Concord evaluations, it may be appropriate to include them in the final historic properties survey report (to be prepared for the preferred alternative).

Pittsburg

- Southern Pacific Railroad Station, at the intersection of Railroad Avenue and the SPRR line (see Map 5). Representative of the simplified style of late nineteenth-century commercial buildings, including railroad stations, this former SP Station appears to be eligible for listing on the National Register. Further research is needed to establish its place in the history of the railroad's development in Contra Costa County. The structure is located in the boundaries of the Pittsburg LRT Station APEI.

- Commercial building on Railroad Avenue next to the Southern Pacific Railroad Station (see Map 5). A utilitarian commercial building stylistically related to the SP Station and probably historically related to the Station's location. Further research would be needed to assess its eligibility for listing on the National Register. This structure is also located in the Pittsburg LRT Station APEI.

- California Theatre, at the intersection of Railroad and Central Avenues (see Map 5). A circa 1930 Streamline Moderne movie house, which appears to meet the criteria for listing on the National Register, but would require further research to evaluate its significance. The theatre is located in the Pittsburg LRT Station APEI.

IMPACTS

Archival research and field review have resulted in the identification of no known prehistoric archaeological resources that are located within the study corridor APEI. As discussed in earlier sections of this report, some archaeologically sensitivity is believed to exist in the downtown Concord area in the vicinity of Concord Avenue and Port Chicago Highway. Likewise, no historic archaeological sites are identified for the project corridor. Archaeological sensitivity, however, associated with the Todos Santos Plaza historic district, is indicated along Concord Avenue between the existing BART station and Galindo Avenue. Historic archaeological sensitivity also exists at the Pittsburg LRT Station in association with the old SP Station.

Several historical properties are identified within the vicinity of the project corridor, three of which are located in the APEI and could be affected by one of the project alternatives.

Section 106 of the National Preservation Act requires that project effects on significant archaeological sites and historic properties be addressed. Significant resources are those properties that are listed or are eligible for listing on the National Register of Historic Places. Department of Interior regulations describe the National Register criteria for listing this way:

> The quality of significance in American history, architecture, archaeology, engineering, and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling, and association, and that (a) are associated with events that have made a significant contribution to the broad patterns of our history; or (b) that are associated with the lives of persons significant in our past; or (c) that embody the distinctive characteristics of a type, period, or method of construction, or that possess high artistic values, or that represent a significant distinguishable entity whose components may lack individual distinction; or (d) that have yielded or may be likely to yield information important in history or prehistory (36 CFR Section 60.4, cited in Advisory Council on Historic Preservation 1986b).

For purposes of the alternatives analysis, the historic properties within the APEI are tentatively regarded as potentially significant cultural resources

subject to direct, adverse impacts. A refinement of the resources inventory would be accomplished with the completion of a Section 106 historic properties survey report in which each of the potentially affected resources would be evaluated by the cited National Register criteria. Such a report would be prepared for the preferred project. Recommendations for the completion of that report are detailed in the mitigation discussion.

Alternative 1

No presently discernible impacts to cultural resources will result from the No-Build Alternative.

Alternative 2

No presently discernible impacts to cultural resources will result from the Transportation Systems Management Alternative.

Alternative 3

No presently discernible impacts to cultural resources will result from the Busway/HOV Lanes to Antioch Alternative. Concord Avenue extends through the Todos Santos Plaza historic district where several historical structures are situated adjacent to the connector alignment. Continued use of the existing roadway would have no adverse effects on the structures. Future right-of-way widening or other improvements could potentially impact some of the identified historic resources. If such improvements include below- ground construction activities between the Concord BART Station and Galindo Avenue, potentially significant historic archaeological deposits could be discovered. There is also a moderate potential for discovering subsurface prehistoric archaeological sites along Concord Avenue as well; the close proximity of CA-CCo-19 suggests this potential.

Alternative 3A

Potential impacts to cultural resources are the same as for Alternative 3.

Alternative 4

No presently discernible impacts to cultural resources will result from the LRT to Antioch via Highway 4 Alternative.

Alternative 4A

No presently discernible impacts to known cultural resources will result from the LRT to West Antioch via Highway 4 Alternative.

Alternative 5

The LRT to Antioch via Highway 4 and Southern Pacific Railroad Alternative could adversely impact the SP Station, the associated building and movie theatre located in the Pittsburg LRT Station on Railroad Avenue. These structures would have to be moved or demolished in order to develop the proposed LRT station and parking area.

Alternative 6

No presently discernible impacts to cultural resources will result from the BART to North Concord/Martinez Alternative.

Alternative 7

No presently discernible impacts to cultural resources will result from the BART to Antioch via Highway 4 Alternative.

Alternative 7A

No presently discernible impacts to cultural resources will result from the BART to West Pittsburg via Highway 4 Alternative.

Alternative 7B

No presently discernible impacts to cultural resources will result from the BART to Pittsburg via Highway 4 Alternative.

Alternative 8

No presently discernible impacts to cultural resources will result from the BART to North Concord/Martinez and LRT to West Antioch via Highway 4 Alternative.

It is noted, however, that moderate subsurface prehistoric archaeological sensitivity may exist on the Port Chicago Highway alignment between the existing Concord BART Station and Olivera Drive. Subsurface construction work could lead to the discovery of prehistoric cultural deposits, although there is no reasonable way to determine if or where such a potentially adverse impact may occur. This sensitivity exists for the other alternatives (4, 4A, 5, 6, 7, 7A and 7B) that also use the Port Chicago alignment.

MITIGATION

In accordance with the UMTA guidelines for alternatives analysis cultural resources evaluations, full compliance with National Historic Preservation Act, Section 106 requirements is not expected at this time. We have documented the known archaeological sites and historic properties in the project area, identified those that could be affected by the project alternatives and presented preliminary discussions regarding their significance. Also, we have identified areas of probable resource sensitivity. The key element in meeting the Section 106 requirements for the preferred alternative will be the completion of an Historic Properties Survey Report (HPSR) in which the National Register eligibility of all potentially impacted resources is determined. Upon the selection of a preferred project, the following procedures are recommended for completing the HPSR.

Archival research should be undertaken to determine the historical significance of potentially affected structures where National Register eligibility is unknown. The appropriate documentation in the form of land title records, city directories, maps, plans, photos and local and regional histories should be researched to establish the historical context of the resource(s) if National Register criteria a or b are applied in significance determination. Standard HPSR forms, including photographs, should be completed and if criteria c is applied a detailed architectural evaluation of the structure(s) should be presented. The completed HPSR should include an assessment of impacts to eligible historic properties within the project APEI and a discussion of site-specific mitigation programs.

Project-related impacts to significant historical properties could be mitigated by the following alternatives.

1. Avoidance of the historical property through modification of the alignment or construction plans that would allow for the preservation of the resource at its present location. This management program could also include restoration of a structure (or district) to a specific period or theme and preservation with adaptive re-use (perhaps with limited interior modifications).

2. Relocation of the historical structure(s) to a place where it can be preserved.

3. If neither of these mitigation alternatives can be implemented and an historical property may be damaged or destroyed, it is recommended that an "Historic American Building Survey" be accomplished for the structure. Such a procedure involves the precise recording of the structure through measurements, drawings and photographs. The documentation of the resource is on standardized forms and is accurate in detail to such an extent that after demolition, the historical structure could be reconstructed from the survey data. Copies of the documents should be filed with all appropriate federal, state and local repositories. This mitigation program could include salvage and selective re-use of building materials and features once the survey is completed.

4. Other, less drastic mitigation measures may be appropriate for alleviating minor or temporary impacts to structures. Such measures may be as simple as avoiding the resource by strictly limiting some construction activities close to building. Monitoring during construction may be included.

An archaeological field survey should be accomplished for the preferred project in those areas that were not surveyed during this preliminary study (see Maps 2 through 7). If previously unknown archaeological sites are discovered, subsurface testing programs should be undertaken to determine the significance of the prehistoric deposits that could be affected by the preferred project. The testing procedures should be designed to specifically determine the boundaries of the site(s), the depositional integrity and the cultural significance (as per criteria d for National Register eligibility) of the resources. These investigations should be conducted by qualified professionals experienced in Contra Costa County prehistoric studies. The testing programs should be conducted within the context of appropriate research considerations and should result in a detailed technical document that defines the exact project impacts to significant resources and presents comprehensive mitigation program(s) for addressing those impacts.

Project-related impacts to prehistoric archaeological sites could be mitigated by the following alternatives.

1. Avoidance of the archaeological site through modification of the project alignment or construction plans that would allow for the preservation of the resource in its present location.

2. Covering or "capping" the site with a protective layer of fill. This could be a very good way of mitigating potential impacts in situations where BART or LRT tracks will be laid at-grade; protective fill can be placed on the site(s), followed by the track grade and construction. Archaeological monitoring during construction should be required.

3. In circumstances where archaeological deposits cannot be preserved through avoidance or capping, data recovery through excavation would be the recommended mitigation. This measure would consist of the methodical excavation of those portions of the site(s) that will be adversely affected. The work should be accomplished within the context of a detailed research design and in accordance with current professional standards. The program should result in the extraction of sufficient volumes of non-redundant archaeological data so as to address important East Bay research considerations. The excavations should be accomplished by qualified professionals and detailed technical reports should result.

Of great importance, in considering subsurface testing and excavations of prehistoric archaeological sites, is the consultation with the local Native American community regarding all aspects of the programs, including the treatment of cultural materials and particularly the removal, study and reinterment of Native American burials. All arrangements concerning these matters should be worked out prior to beginning the archaeological programs.

Regarding historic archaeological resources, detailed archival research in combination with subsurface testing is recommended for the sensitive area surrounding the old SP Station and associated building in the proposed LRT

station and parking area on Railroad Avenue in Pittsburg. These procedures would be necessary in determining if significant below-ground resources would be impacted. Similar procedures are recommended if future road improvements are proposed for Concord Avenue between the existing Concord BART Station and Galindo Avenue. These investigations should also be conducted within the context of appropriate historical research considerations and should result in a detailed technical document that identifies the location and significance of cultural deposits, defines the exact impacts that will result from project construction and present a comprehensive mitigation program(s) for the resources. Mitigation alternatives would likely include: 1) avoidance of the resource(s) with preservation in place; 2) covering the site with a protective layer of fill; 3) data recovery through excavation with similar recommendations as presented for prehistoric sites regarding professional procedures and reporting.

In areas where no known archaeological sites are documented, but where moderate archaeological sensitivity is identified, professional archaeological monitors should observe the subsurface construction in order to prevent or minimize damage to potentially significant cultural deposits that could be exposed during construction. Where sensitivity for prehistoric resources is present, Native American monitors should be involved. In the event that subsurface deposits or features are encountered, construction work in the immediate vicinity of the find should be halted, the proper authorities should be informed and an appropriate course of action developed that is acceptable to all concerned parties. All such procedures should be conducted within the context of federal, state and local cultural resources management requirements. In the event that cultural deposits are discovered during unmonitored construction, an archaeologist should be consulted and similar procedures should be implemented.

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1911, 1917 and 1927

KEY TO MAPS 2 THROUGH 7

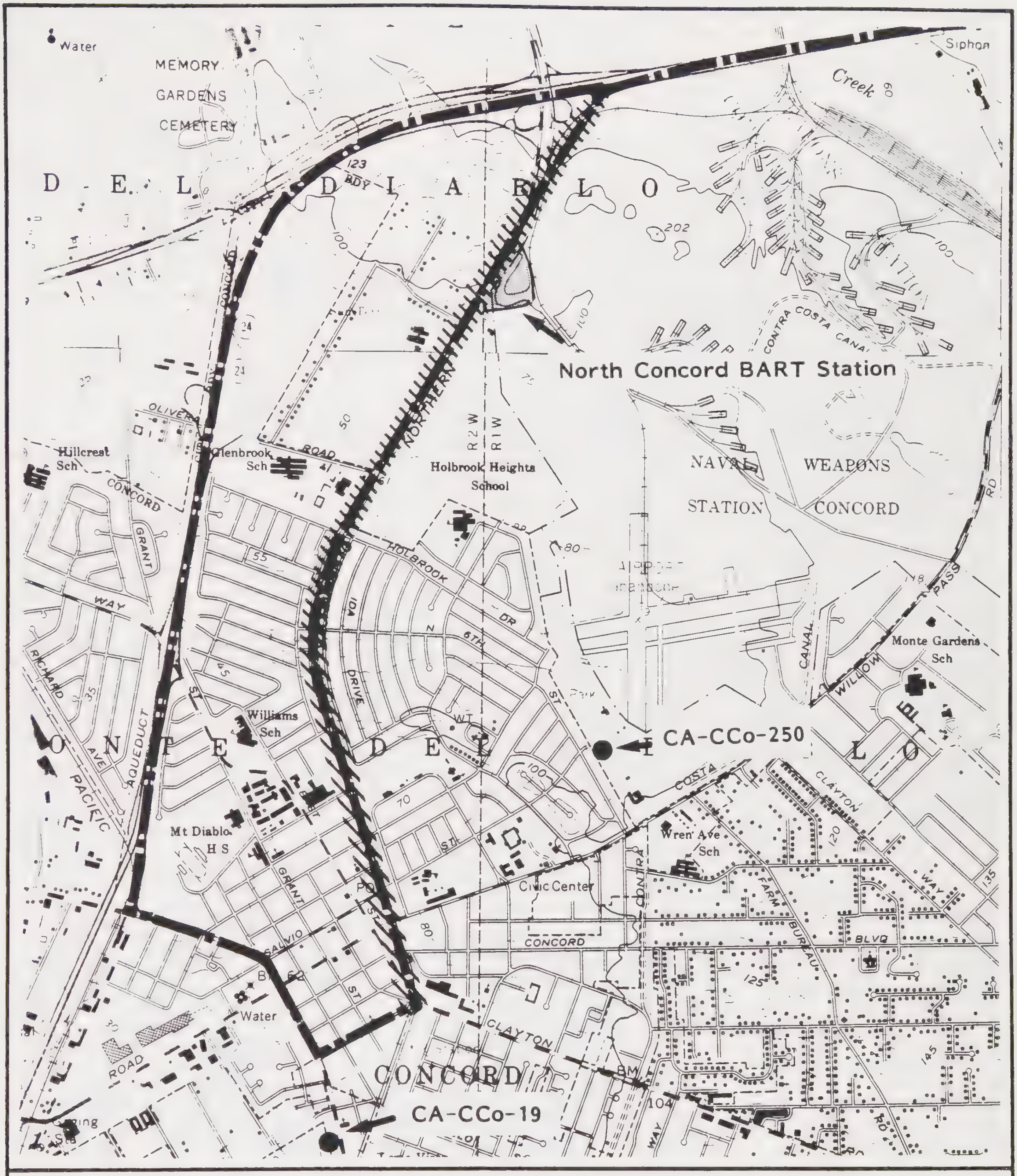
Study Corridor

Station Locations

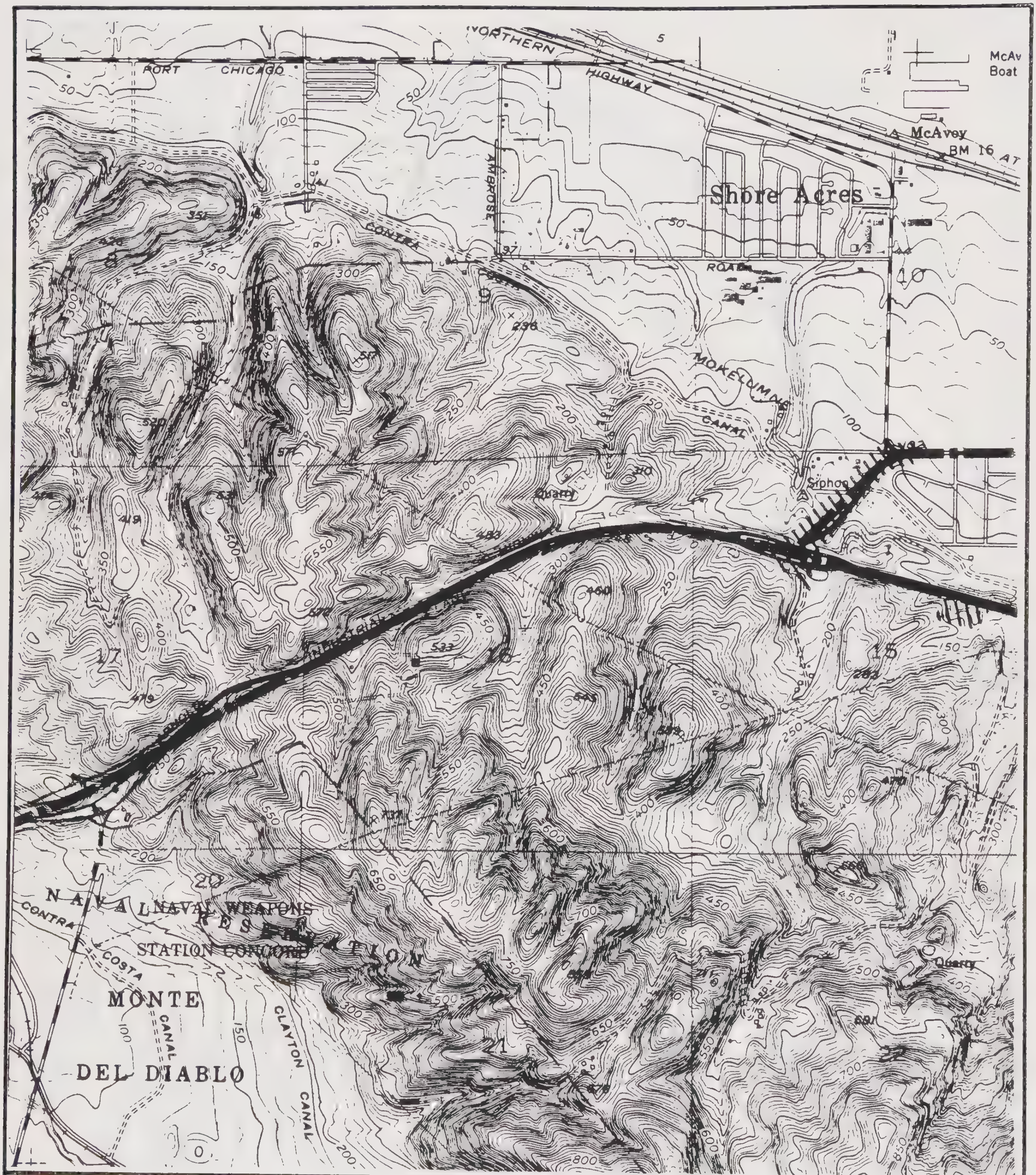
Archaeological Sites

Historical Sites

Areas Surveyed

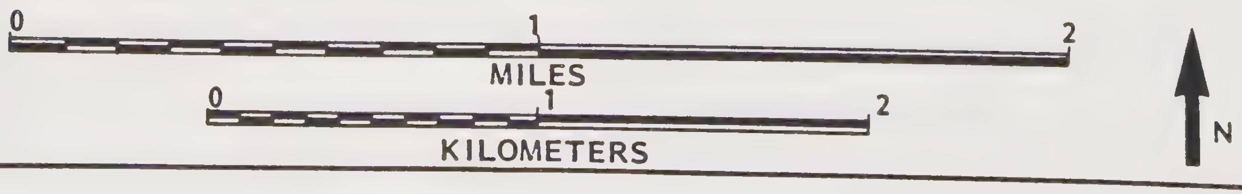


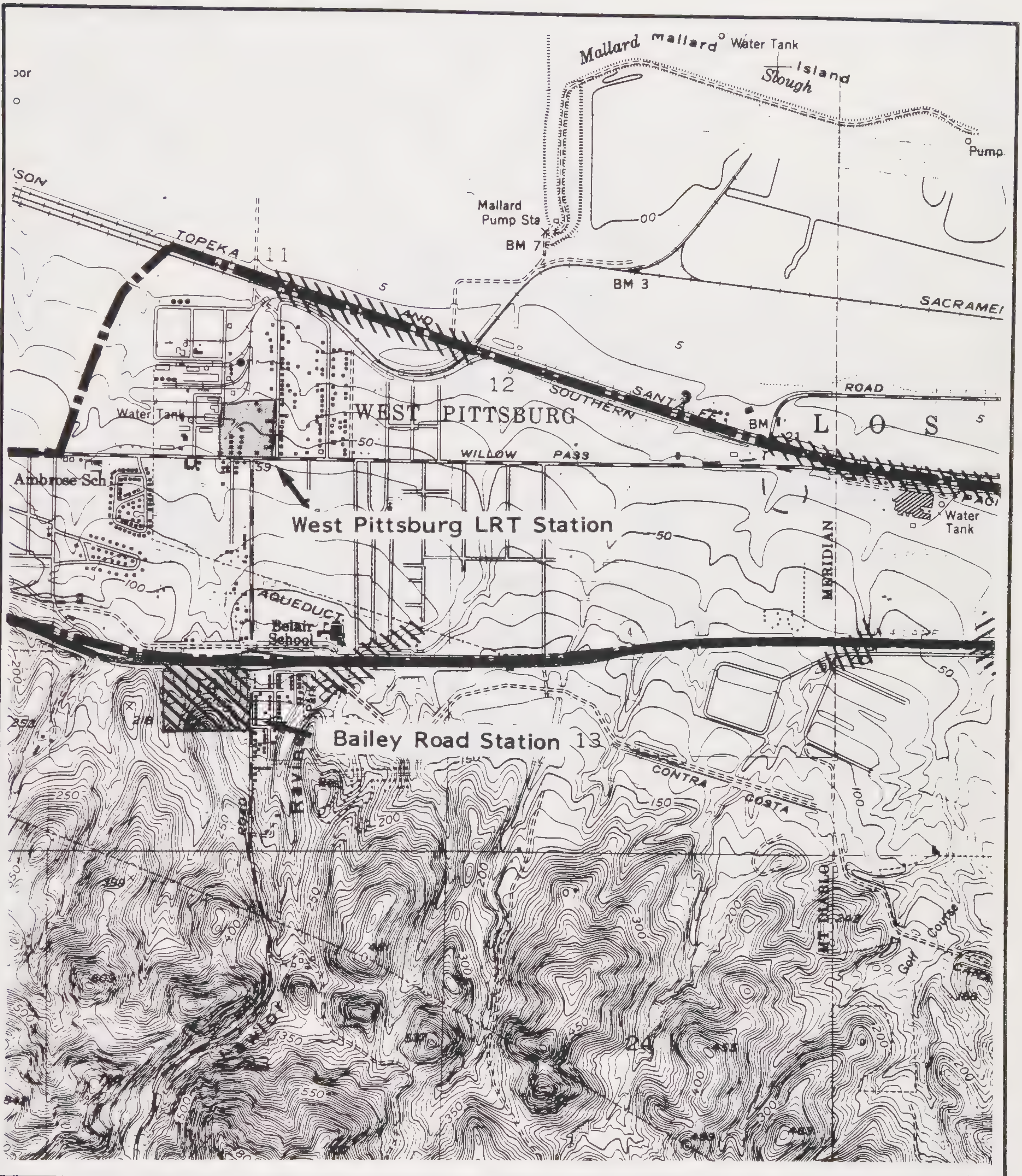
MAP 2: BART, LRT and HOV Corridor
SOURCE: USGS Walnut Creek, Calif., 7.5' Quad, 1959 (photorevised 1980) and USGS Vine Hill, Calif., 7.5' Quad, 1969 (photorevised 1980)



MAP 3: BART, LRT and HOV Corridor

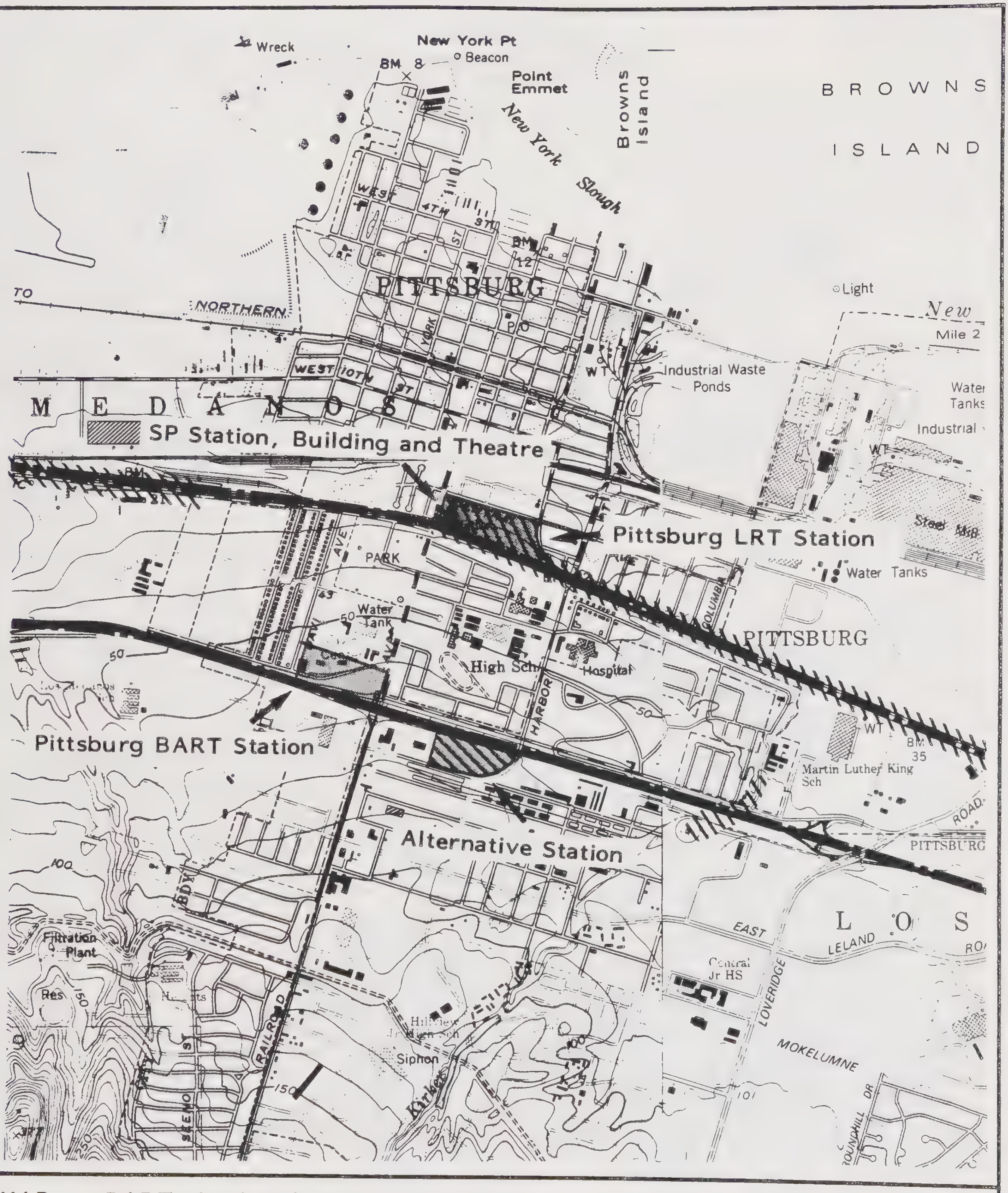
SOURCE: USGS Honker Bay, Calif., 7.5' Quad, 1953 (photorevised 1980)





MAP 4: BART, LRT and HOV Corridor

SOURCE: USGS Honker Bay, Calif., 7.5' Quad, 1953 (photorevised 1980)



MAP 5: BART, LRT and HOV Corridor

SOURCE: USGS Honker Bay, Calif., 7.5' Quad, 1953 (photorevised 1980) and USGS Antioch North, Calif., 7.5' Quad, 1978

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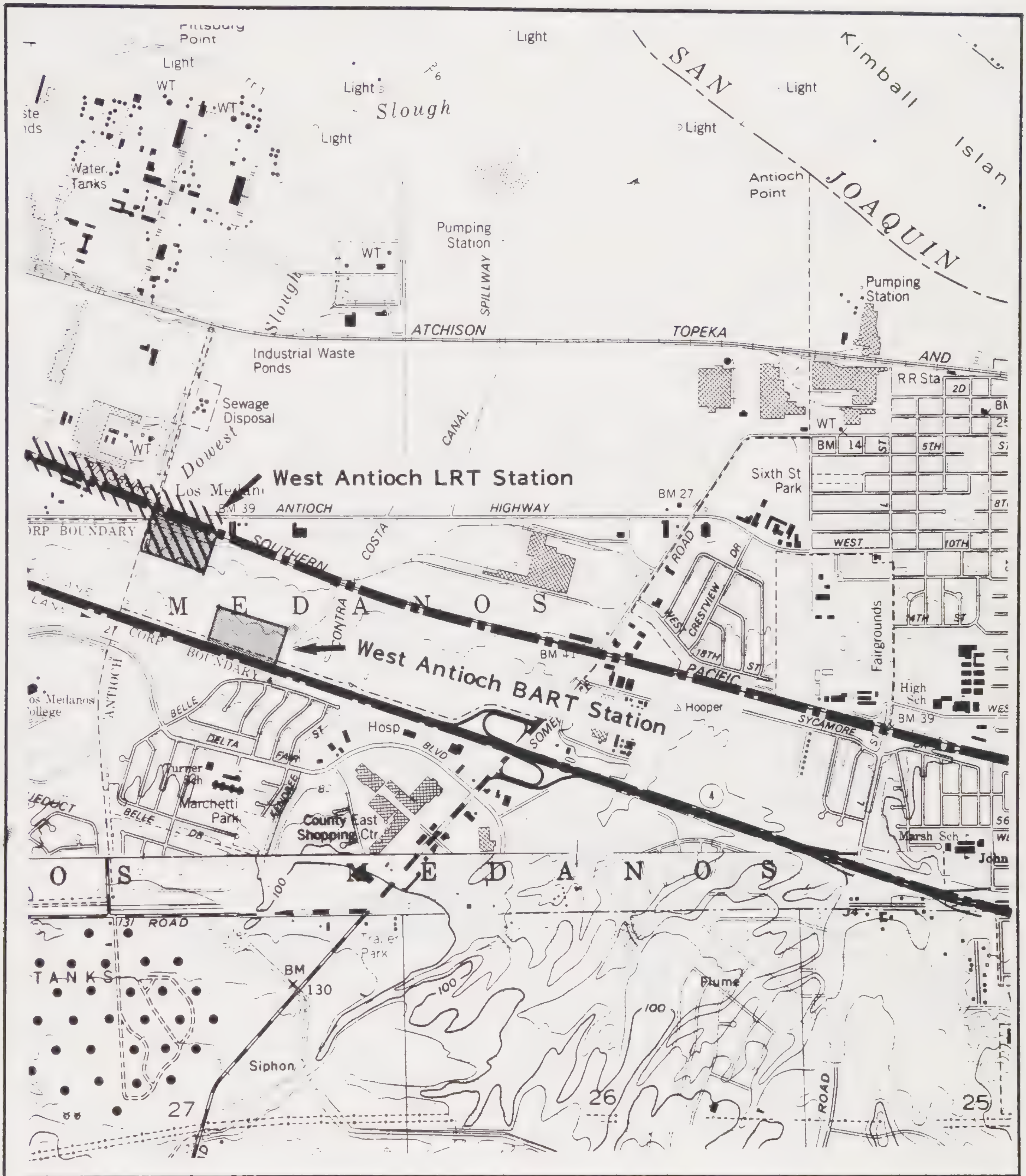

MAP 6: BART, LRT and HOV Corridor

SOURCE: USGS Antioch North, Calif., 7.5' Quad, 1978 and
USGS Antioch South, Calif., 7.5' Quad, 1953 (photorevised 1980)

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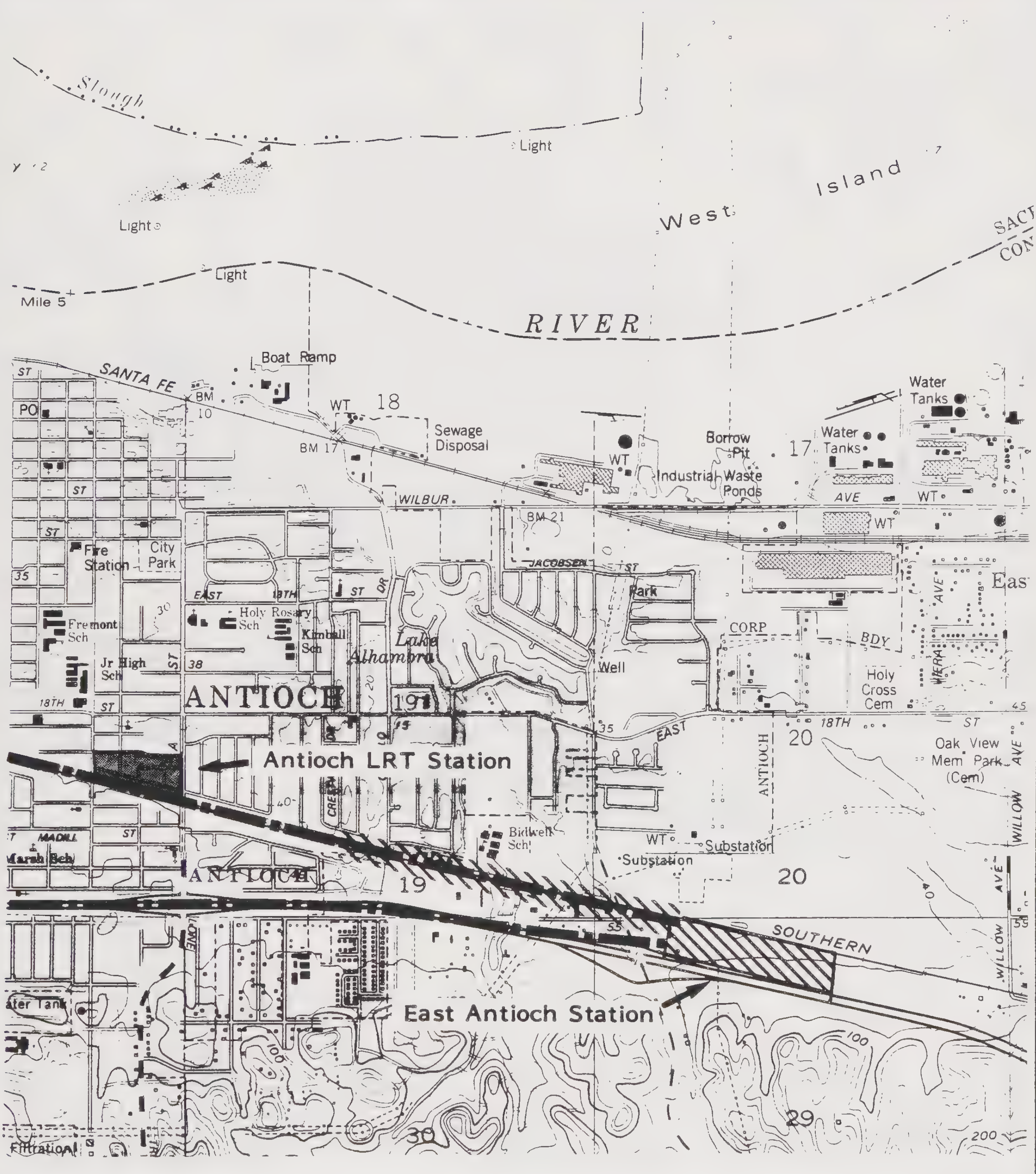
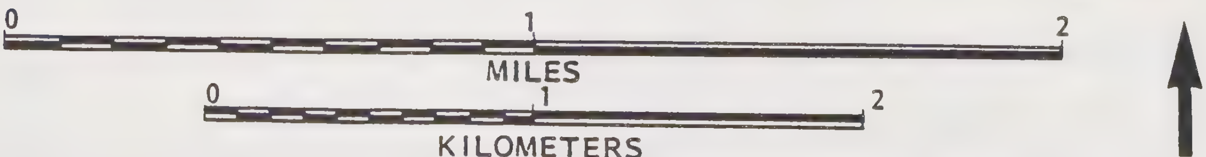


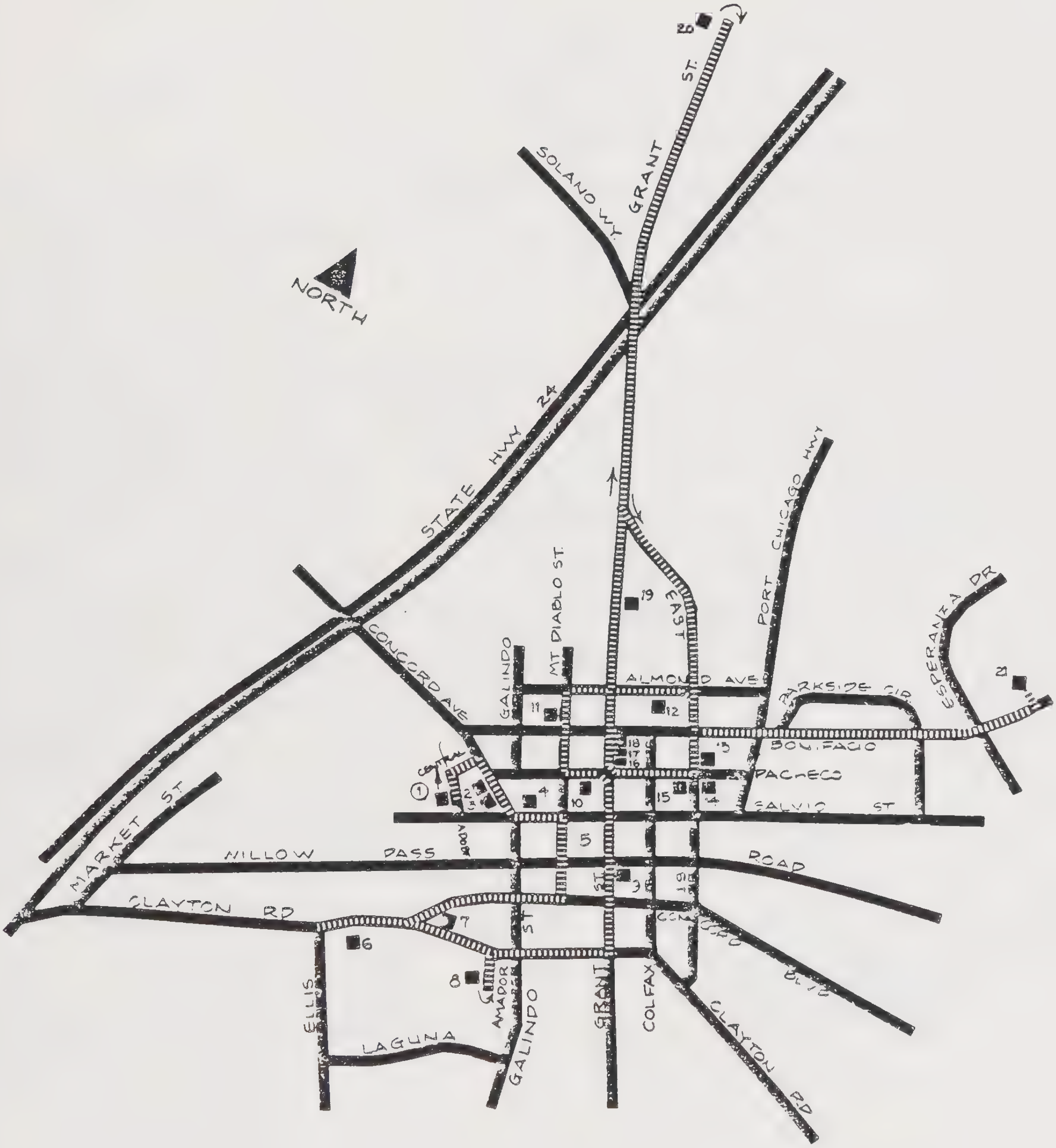
MAP 7: BART, LRT and HOV Corridor

SOURCE: USGS Antioch North, Calif., 7.5' Quad, 1978 and
USGS Antioch South, Calif., 7.5' Quad, 1953 (photorevised 1980)



KEY TO MAP 8

1. Salvio Pacheco Adobe, 1870 Adobe Street
2. Concord Fire Hall, 1982 Concord Avenue
3. Perry House, 1990 Concord Avenue
4. Foskett and Elworthy Building, 2001 Salvio Street
5. Todos Santos Plaza bordered by Willow Pass, Mt. Diablo, Salvio and Grant Streets
6. Keller House, 1760 Clayton Road
7. Ivey House, 1847 Clayton Road
8. Francisco Galindo House, 1721 Amador Avenue
9. County Fire House, 2210 Willow Pass Road
10. Elworthy-Keller House, 2156 Pacheco Street
11. Webb-Soto House, 2243 Mt. Diablo Street
12. Nunes House, 2334 Almond Avenue
13. Elworthy House, 2118 East Street
14. Barnett House, 2080 East Street
15. Melty-McKinnon House, 2099 East Street
16. Bibber House, 2108 Grant Street
17. Neustaedter House, 2156 Grant Street
18. Alves House, 2190 Grant Street
19. Mt. Diablo High School Site, 2455 Grant Street
20. Fernando Pacheco Adobe, 3115 Grant Street
21. Maltby Mansion, 3033 Bonifacio Street



MAP 8: Concord Historical Landmarks

SOURCE: City of Concord, Planning Department/Concord Historical Society Newsletter, Landmarks Edition, September 1986

APPENDIX

List of Contacts

LIST OF CONTACTS

Organization/Agency	Person	Month/Year	Type of Contact	Topic Discussed
State Historic Preservation Office, Sacramento	Hans Kruetsburg, Historian	August 1986	Telephone Call	Cultural Resources Methodologies and Area of Potential Environmental Impact
Native American Hertiage Commission, Sacramento	William A. Johnson	May 1987	Letter and Telephone Call	Native American Cultural Resources
California Department of Transportation, District 4, San Francisco	John Holson, Archaeologist	May 1988	Personal Contact	Caltrans Record Review and Historic Bridges Inventory
Contra Costa County Native American Heritage Preservation Project, San Pablo	Wayne Roberson	June 1987	Telephone Call	Native American Cultural Resources
Concord Historical Society, Concord	Ruth Galindo Former President	July 1987	Telephone Call	Historic Resources in Project Area
City Planning Department, Concord	Ed Philips, Planner	July 1987	Telephone Call	Historic Resources in Project Area and the Relationship between the Historic Landmarks Program and the Concord Historical Society
City Planning Department, Concord	David Golick, Planner	June 1987	Personal Contact	Historical Landmarks in Concord and Potentially Significant Properties in the Study Area
Pittsburg Historical Society, Pittsburg	Marty Aiello, Board Member and Past President	June 1987	Telephone Call	Historical Structures in Pittsburg
Department of City Planning, Pittsburg	Dean Parson, Planner	June 1987	Personal Contact	Historical Buildings and Districts in Pittsburg

Appendix D

Technical Report on Noise and Vibration

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PITTSBURG-ANTIOCH CORRIDOR TECHNICAL REPORT ON NOISE AND VIBRATION

JULY 1988

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1. INTRODUCTION

This technical report presents a detailed analysis of the noise and vibration impact on the community within the Pittsburg-Antioch Corridor study area. Material contained herein is supporting documentation for the analysis and conclusions pertaining to noise and vibration impact presented in the Pittsburg-Antioch Corridor AA/DEIS/DEIR.

The current study examines the expected impacts of eight alternatives proposed for the Pittsburg-Antioch Corridor (Corridor). The various proposed alternatives, with the exception of the No-Build and Transportation Systems Management (TSM) Alternatives, would extend service to several locations between Concord and East Antioch. These alternatives involve in various combinations, extension of service from the existing Concord BART station with BART vehicles and/or LRT vehicles or High Occupancy Vehicle buses (HOV).

This report presents a study of the ambient noise and ground-borne vibration characteristics existing at the present time and expected at the time of implementation of transit service along the Corridor. The impact of the existing and future noise environment on the local inhabitants has been the subject of many studies conducted for new building projects within the communities in the Corridor. In addition, noise studies have been performed for the various Noise Elements which are contained in the respective General Plans for the Cities of Antioch, Concord, and Pittsburg and Contra Costa County. These studies demonstrate a concern, on the part of the local governmental agencies, for reducing the impact of noise on the communities they serve.

The problem of ground-borne vibration within a suburban setting is not one that most communities face. Sources of vibration in most communities are due to surface traffic (e.g., trucks, buses) and occasionally large mechanical equipment. Due to the nature of ground-borne vibration, the extent of a community affected is much less than for airborne noise. Except in rare instances, the levels of existing ground-borne vibration transmitted to adjacent buildings is low enough to be imperceptible. Not unexpectedly, there are no publicly available studies of ambient ground vibration known to exist for communities within the Corridor area.

To supplement the noise data contained in past studies with data specific to the Corridor Alternative alignments, and establish a baseline of representative ambient community vibration data, additional measurements were conducted for the current impact analysis. Ambient noise and vibration measurements were made outside representative buildings and in representative areas along the proposed alignments to provide data on typical existing ambient levels. The data are used to classify the current community environments, and to provide assistance in determining the appropriate levels of acceptable community noise and vibration from transit trains and HOV.

These data used in conjunction with the noise and vibration design criteria provide a basis for determining those areas where special design features may be required to reduce the noise and vibration from transit train or HOV operations to acceptable levels for each alternative.

The noise and vibration survey sections discuss the survey locations and procedures, present background information on noise and vibration measurements and descriptors, present the results of the measurements and identify community areas and individual structures along the alignment that may require particular attention to assure acceptable noise and vibration levels.

2. SURVEY PROCEDURE AND BACKGROUND INFORMATION

Establishing the existing noise levels or noise environment in a community requires measuring the noise at a number of locations at several different times of day and, preferably, on several different days and times of the year. Community noise is a continually fluctuating entity dependent on many factors. Because the noise level does fluctuate over a relatively wide range during the course of a day, it is necessary to make measurements which are statistically significant and which can be analyzed on a statistical basis.

Establishing the existing vibration environment requires the same procedures and has the same general statistical variations as does the existing noise environment. Although reference is made throughout this section to ambient or community noise, this discussion for the most part is equally applicable to vibration.

In the current AA/DEIS/DEIR study for the Corridor, there are eight main alternatives and four minor alternatives. The minor alternatives are subsets of three of the main alternatives. Each is a shortened version of one of the main alternatives. The main alternatives consist of the No-Build (existing system and programmed improvements), the Transportation System Management, two Light Rail Transit (LRT) alternatives, one HOV alternative, and three BART alternatives.

The main and sub-alternatives are:

Alternative 1 - No Build (Existing System and Programmed Improvements)

Alternative 2 - Transportation Systems Management (TSM)

Alternative 3 - Busway/High Occupancy Vehicle (HOV) Lanes to Antioch

Alternative 3A - Busway/High Occupancy Vehicle (HOV) Lanes to Pittsburg

Alternative 4 - Light Rail Transit (LRT) to Antioch via Highway 4

Alternative 4A - Light Rail Transit (LRT) to West Antioch via Highway 4

Alternative 5 - Light Rail Transit (LRT) to Antioch via Highway 4 and Southern Pacific Railroad

Alternative 6 - BART to North Concord/Martinez

Alternative 7 - BART to Antioch via Highway 4

Alternative 7A - BART to West Pittsburg via Highway 4

Alternative 7B - BART to Pittsburg via Highway 4

Alternative 8 - BART to North Concord/Martinez, Light Rail Transit (LRT) to West Antioch via Highway 4

Alternative 1 (No Build) is shown in Figure 2-1. The alignments for Alternatives 3 through 8 are shown in Figures 2-2. A detailed description of the land use adjacent to the various alternatives is given in Table 2-1.

Beginning at the existing Concord BART Station, the proposed rail alignments would extend northward on aerial structure passing through mixed commercial and residential community and then to the median of Port Chicago Highway before going to a transition to a

predominantly at-grade alignment on the east side of the highway with approximately 1-3/4 miles of primarily residential community on both sides. Also within the first two miles of the route are churches, schools, and a hospital that would be affected.

Both BART and LRT Alternatives join Highway 4, also referred to as SR-4, at its intersection with Port Chicago Highway. Most of the rail alternatives extend the rest of the alignment in the median of Highway 4 through West Pittsburg, Pittsburg and Antioch, depending on the terminal point of the Alternative. The community along Highway 4 is largely residential, with intermittent commercial, undeveloped, and industrial areas. There are also several schools, churches and a medical center adjacent to this alignment.

The LRT alignment (Alternative 5), which would be along the Southern Pacific Transportation Company (SPTC) right-of-way, would pass through a mix of residential, commercial, and industrial areas.

The busway/HOV Alternative follows a different route initially until it meets up with the other alignments at Port Chicago Highway and Highway 4 in the northern part of Concord. The first part of this route is west through primarily commercial areas of Concord on heavily traveled city streets to State Route 242 (SR 242).

Selection of new measurement locations was based on the availability of recent noise data for each of the various sections of the different alignments. The nature of existing noise sources in the Corridor was also used in the selection process. Emphasis was given to the Concord portion of the Corridor, considering the combined factors of somewhat lower levels of existing noise and close proximity of the proposed rail alignments to residences in this area.

For the commercial areas, with principally daytime occupancy, the possibility of intrusion from transit train operations is primarily a daytime consideration. In residential areas, the community ambient or background noise level is generally the lowest during the evening and nighttime hours and the possibility of intrusion from transit train operations is greatest during this time period. Although community noise data for the daytime in commercial areas and noise data for the evening and nighttime in residential areas are sufficient to establish the design criteria and evaluate the potential impact of the transit system, such measurements are not sufficient for a complete assessment of the community area environment. Therefore, measurements are generally made to provide data on the existing noise levels during several different times of the day.

Complete 24-hour surveys of the noise level can be performed in order to obtain a complete statistical representation of the daily noise exposure in a community area. It has been found, however, that the noise in communities can also be characterized adequately by making spot-check measurements during at least four characteristic times of day. Because of the purpose of the noise measurements reported herein, the spot-check type of survey with a measurement duration of 10 minutes was performed at all but one of the measurement locations during appropriate characteristic times of day. These data are supplemented by complete 24-hour noise surveys at six selected measurement locations.

A total of eleven new measurement locations were chosen as representative of areas along the proposed alignment. The locations of the new measurement sites in the Corridor are indicated in Figure 2-3. A brief description of each measurement location and its relation to the various Alternatives and their alignments is given in Table 2-2. All of the noise and vibration data for these surveys were obtained between May 9 through 12, 18

and 19, 1988. Results of the noise and vibration surveys are presented in Section 3, EXISTING NOISE LEVELS and Section 4, EXISTING VIBRATION LEVELS.

In addition to the measurements made explicitly for the Pittsburg-Antioch Corridor impact study, there are available relevant noise data from measurements by others for fourteen other locations in the corridor. These data are given in Section 3.

For the purpose of this study the day was divided into four characteristic measurement periods representing:

Daytime:	10:00 a.m. to 2:00 p.m.
Rush Hour:	4:30 p.m. to 6:30 p.m.
Evening:	7:00 p.m. to 10:00 p.m.
Nighttime:	11:00 p.m. to 2:00 a.m.

No data were taken during the morning rush hour because it is generally found that the noise level results are essentially the same as for the evening rush hour.

The results of the noise measurements and the description of the noise environments prevailing at each of the measurement locations in the community are based on a statistical analysis of the observed noise levels in decibels. The factors derived from the analysis are the levels exceeded 99% of the time, 90% of the time, 50% of the time, 10% of the time, and 1% of the time designated L_{99}, L_{90}, L_{50}, L_{10}, and L_1, respectively.

L_{99} and L_{90} are descriptors of the typical minimum or "residual" background noise level observed during a measurement period, normally made up of the summation of a large number of sound sources distant from the measurement position and not usually recognizable as individual sound sources. The most prevalent source of this residual noise is distant street and highway traffic, but L_{99} and L_{90} are not strongly influenced by occasional local motor vehicle passbys. However, they can be influenced by nearby stationary sources such as air conditioning equipment.

L_{50} represents a long-term statistical average or median sound level over the measurement period and reveals the long-term influence of local traffic. If the instantaneous sound level is sampled over a measurement period, the sound level will be above L_{50} 50% of the time.

L_{10} describes the average peak or maximum sound level occurring for example, during nearby passbys of trucks, buses, automobiles, trains, or airplanes. Thus, while L_{10} does not describe the long-term noise prevailing it does describe the typical maximum noise levels observed at a point and is strongly influenced by the momentary maximum sound level occurring during vehicle passbys.

L_1, the sound level exceeded 1% of the time, is representative of the occasional maximum or peak sound level which occurs in an area.

Because of some inherent deficiencies of the simple percentile measures described above in evaluating the noise exposure effects of short duration, high level sounds (such as truck or bus passbys), the Energy Equivalent Level, L_{eq}, has been developed and is widely used as a valid single-number descriptor of environmental noise. Because it is an energy integral over time, L_{eq} represents the constant or steady sound level which would give

the same energy level as the fluctuating value integrated over the total time period. Because sound energy is proportional to the square of the sound pressure, L_{eq} places more emphasis on high noise level periods than does L_{50} or a straight arithmetic average of noise level over time. Some consider L_{eq} a more useful measure than L_{50} for the average or typical noise exposure in an area and most recent evaluation systems such as CNEL (Community Noise Equivalent Level) or L_{dn} (Day/Night Average Level) use the energy equivalent concept. Additional definitions and discussion of acoustical terms are contained at the end of this report in GLOSSARY AND SIGNIFICANCE OF ACOUSTICAL TERMS.

TABLE 2-1 LAND USAGE ADJACENT TO ALIGNMENTS IN THE PITTSBURG-ANTIOCH CORRIDOR

Station Number	Description of Land Usage
Alternative 3 Alignment	
0+00 to 105+00	Mostly commercial and office buildings with some industrial buildings along Galindo Street and Concord Avenue.
105+00 to 204+00	Primarily single-family houses east and west of SR-242 with some apartments and commercial buildings west of SR-242.
240+00 to 950+00	Refer to description for Alternatives 4, 7 and 8 (Station 140+00 to 850+00).
Alternatives 4 through 8 Alignment	
8+00 to 23+00	Primarily commercial buildings with single-family houses between Sinclair Avenue and Concord Boulevard. Offices and apartments in vicinity of Willow Pass Road.
23+00 to 77+00	Primarily single-family houses with medical offices between Salvio Street and Bonifacio on Port Chicago Highway. John F. Baldwin Park east of alignment from Bonifacio North. Mt. Diablo Hospital between Bacon Avenue and High School Avenue, west of alignment.
77+00 to 130+00	Primarily single-family houses with commercial buildings between Gehringer Drive and Olivera Road on Port Chicago Highway. Preschool and church west of alignment near Ranchito Drive.

Station Number	Description of Land Usage
130+00 to 320+00	Mostly undeveloped land. Golf course north of SR-4 at Port Chicago Highway intersection. Industrial buildings 200 ft north of SR-4 at Kinnie Boulevard and Concord Naval Weapons Station, both to south and north.

Alternatives 4, 7, and 8 Alignment

320+00 to 391+00	Primarily single-family houses.
391+00 to 420+00	Primarily single-family houses. Bel-Air Elementary School north of SR-4, 600 ft east of Bailey Road. Ambrose Park south of alignment 800 ft east of Bailey Road.
420+00 to 540+00	Primarily single-family houses. Apartments one mile west of Railroad Avenue.
540+00 to 672+00	Single-family houses north, industrial buildings south.
672+00 to 688+00	Primarily single-family houses. Kaiser Medical Facility south of alignment and west of Bailey Road.
688+00 to 761+00	Apartments and single-family houses.
761+00 to 811+00	Mixed commercial buildings, apartments, and single-family houses.
811+00 to 841+00	Commercial and residential buildings north of alignment. Churches south between Windsor Drive and Harbour Drive.

Alternative 5 Alignment

320+00 to 350+00	Residential area including apartments and single-family houses. Church on Willow Pass Road east of Port Chicago Highway intersection.

Station Number	Description of Land Usage
350+00 to 360+00	Mixed commercial buildings and residences.
360+00 to 455+00	Undeveloped land.
455+00 to 474+00	Commercial buildings south of alignment.
474+00 to 619+00	Primarily single-family houses. Park west of Railroad Avenue and Pittsburg High School west of Harbour Street, both south of alignment.
619+00 to 735+00	Primarily commercial and undeveloped land.
735+00 to 782+00	Mixed residential and commercial buildings. Antioch High School between L Street and G Street north of alignment.
782+00 to 835+00	Primarily residential buildings. Commercial buildings near A Street.

TABLE 2-2 LOCATIONS USED FOR EVALUATION OF THE NOISE AND VIBRATION ENVIRONMENT ALONG THE PROPOSED ROUTES

Location Number	Station Number (Alternative)	Approximate Perpendicular Horizontal Distance from Near Track Centerline (ft)	Site Description
1 (24-hour Survey)	38+00 (4 through 8)	100	On sidewalk on southern side of Bacon Street, approximately 80 ft west of Port Chicago Highway and near entrance to Mt. Diablo Hospital parking lot (equipment fixed to telephone pole).
1	38+00 (4 through 8)	100	Same as 24-hour Survey location, except on northern side of Bacon Street.
2	57+00 (4 through 8)	100	On sidewalk, in front of 3165 Claudia Drive on west side of street, 5 ft from curb.
3 (24-hour Survey)	98+00 (4 through 8)	50	At edge of asphalt on Esperanza Drive, approximately 75 ft from edge of northbound lane of Port Chicago Highway (equipment fixed to telephone pole).
4 (24-hour Survey)	348+00 (5)	25	On berm on northern side of Willow Pass Road, approximately 25 ft from edge of westbound throughlane (equipment fixed to telephone pole).
4	348+00 (5)	20	Same as 24-hour survey location site, except on sidewalk, approximately 20 ft from westbound lane.
5 (24-hour Survey)	504+00 (4,7,8)	150	On sidewalk on southern side of Frontage Road near intersection with Chelsea Way, approximately 150 ft from nearest eastbound lane of SR-4 (equipment fixed to traffic sign.
6	619+00 (5)	250	On sidewalk in front of St. Mark Missionary Baptist Church, 900 block of Carpino Avenue.

Location Number	Station Number (Alternative Numbers as Specified)	Approximate Perpendicular Horizontal Distance from Near Track Centerline (ft)	Site Description
7	709+00 (4,7,8)	175	In parking lot of Runaway Bay Apartments, at 2201 San Jose Drive, approximately 175 ft from median of SR-4.
8 (24-hour Survey)	760+00 (4,7,8)	200	On sidewalk on east side of G Street, approximately 15 ft north north of Drake Street and 200 ft north of SR-4 (equipment fixed to lamppost).
9	797+00 (4,7,8)	200	On sidewalk on Lincoln Lane near intersection with East Tregallas Road and approximately 200 ft from median of SR-4.
10	820+00 (4,7,8)	1,000	On sidewalk in front of 2822 Patricia Avenue near intersection with Shaddick Drive and approximately 1,000 ft from SR-4.
11 (24-hour Survey)	75+00 (4 through 8)	200	On sidewalk on north side of Gehringer Drive, approximately 160 ft from median of Port Chicago Highway.

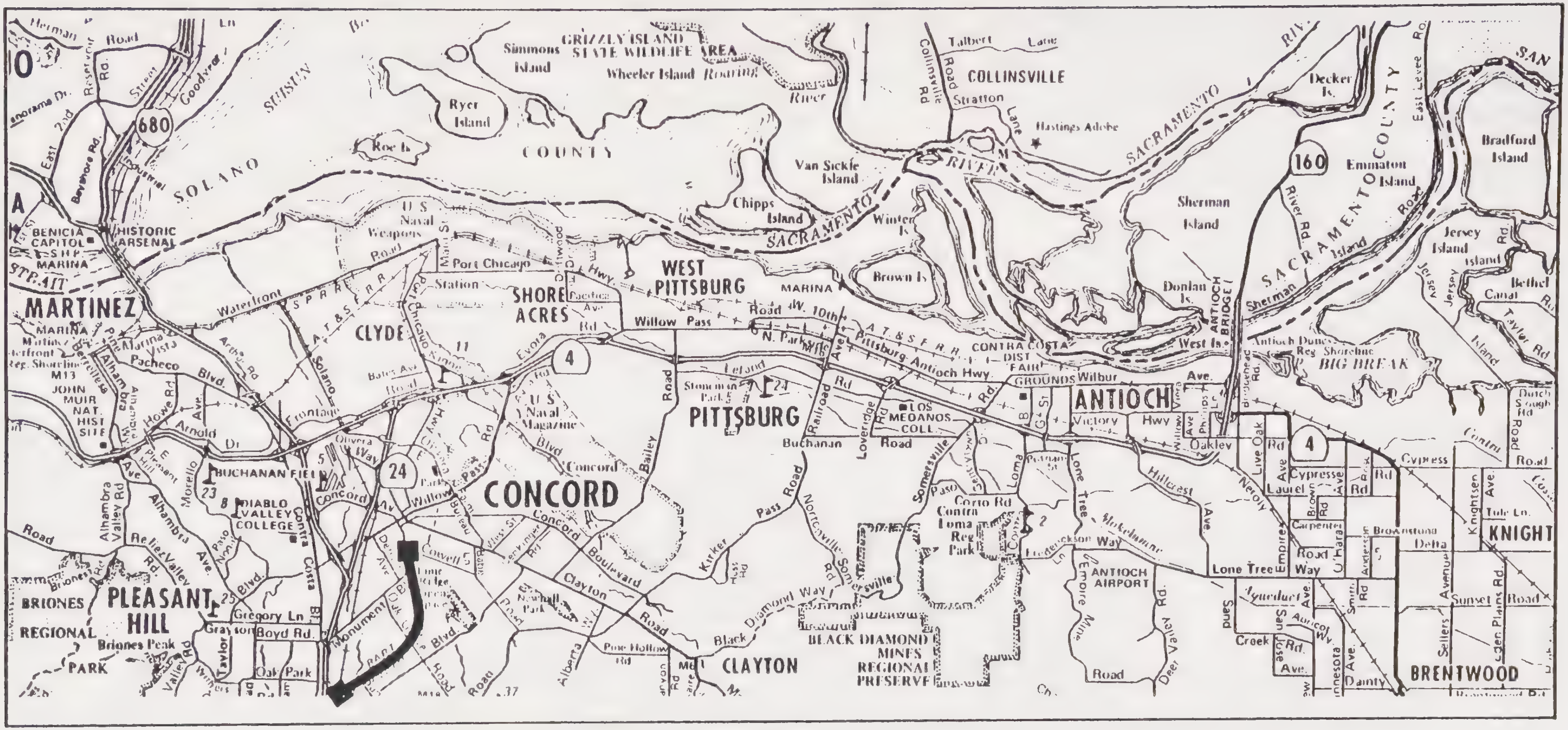
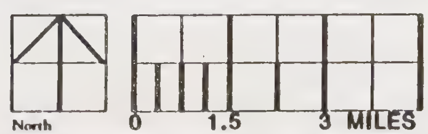


FIGURE 2-1 PLAN OF ALTERNATIVE 1 (NO BUILD)
FOR PITTSBURG-ANTIOCH CORRIDOR



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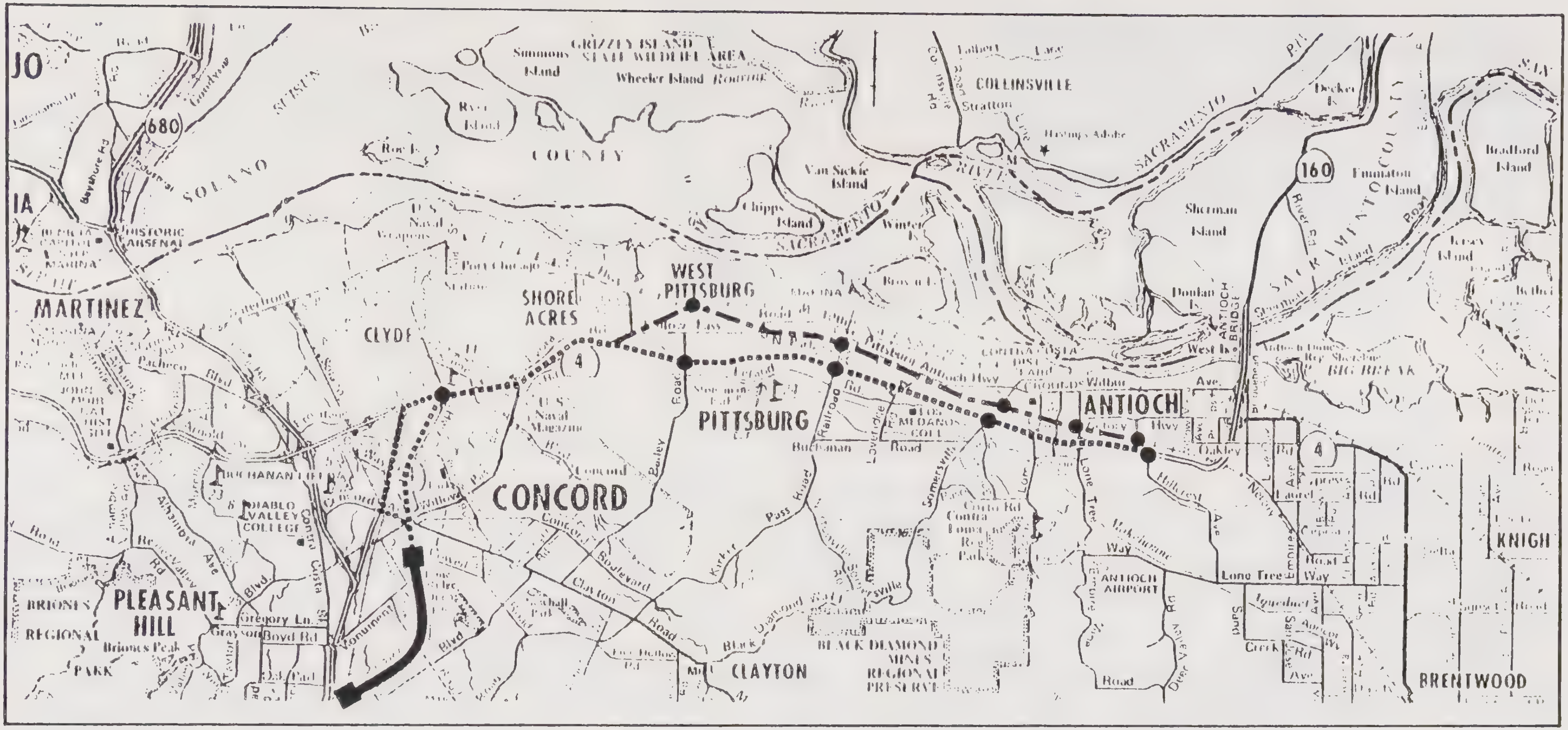

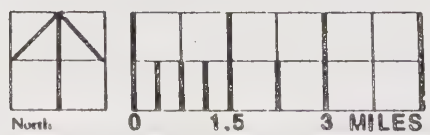

FIGURE 2-2 ALIGNMENTS OF ALTERNATIVES #3-8 FOR PITTSBURG-ANTIOCH CORRIDOR

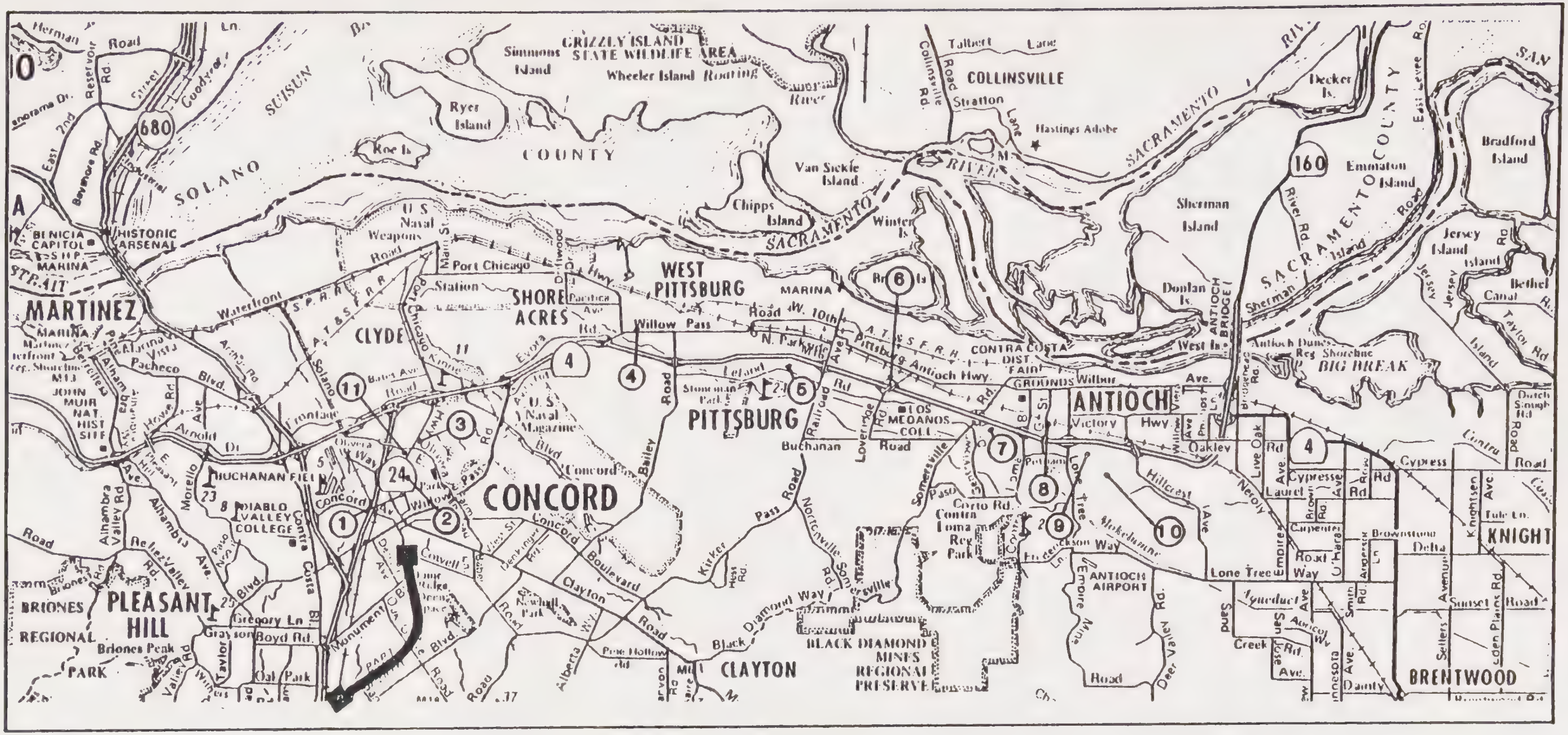

FIGURE 2-3 LOCATION OF AMBIENT NOISE AND VIBRATION MEASUREMENT SITES #1-11 FOR PITTSBURG-ANTIOCH CORRIDOR

North 0 1.5 3 MILES

BART

3. EXISTING NOISE LEVELS

Table 3-1 presents a tabulation of the statistical analysis of the noise observed at the ten short-term noise measurement locations. All of the noise levels are presented in terms of A-weighted sound level in decibels, abbreviated dBA. This measurement scale is used because it has become accepted as the best compromise scale, using frequency weighting which approximates the hearing characteristics of the average human ear. The A-weighted sound level shows good correlation of the subjective response of people and communities with measured noise levels. Also, most noise ordinances, standards and specifications are written in terms of A-weighted sound level. Figure 3-1 indicates typical A-weighted sound levels for some common noises.

To determine the noise data in Table 3-1, each measurement consisted of a ten minute long continuous sample of noise at the site, recorded by means of a calibrated multi-channel precision magnetic tape recorder equipped with a sound level meter microphone. The recordings obtained were later analyzed to obtain the statistical distribution and other descriptors of the noise levels. The tape recordings can be used in the future to obtain a spectral analysis of the noise at the sites (such as octave band or 1/3 octave band analyses) and are permanently retained as a record of the noise environment existing at the time of the measurements.

Each measurement location was chosen to obtain the noise levels characteristic of an area or near a potentially noise sensitive building or group of buildings. Wherever possible the measuring microphone was located at the set back line of the nearby buildings.

Review of the sound level data obtained during the spot-check or 10-minute measurements indicates that the residual background noise levels, L_{99} and L_{90}, range from 38 to 65 dBA during the rush hour and day, and 39 to 61 dBA during the evening and nighttime hours. At most locations the noise levels do show a significant decrease during the evening and nighttime hours when compared with the rush hour and daytime noise levels.

The median or L_{50} noise level for the different sites ranges from 50 to 68 dBA during the rush hour, 47 to 67 dBA during the day, 47 to 65 dBA during the evening, and 41 to 60 dBA during the night. As with the residual background noise levels, the L_{50} noise level generally shows a significant decrease during the evening and nighttime hours.

The data for L_{10} and L_1 are typical for the high level short duration noise producing activities characteristic of each measurement location. For Locations 1, 3 and 11, the L_{10} and L_1 noise levels are influenced by automobile traffic on Port Chicago Highway. For Locations 2, 6 and 10, the L_{10} and L_1 noise levels are influenced by and are characteristic of local neighborhood motor vehicle traffic. Location 4 is immediately adjacent to Willow Pass Road in West Pittsburg, and the L_{10} and L_1 noise levels are primarily from the truck traffic. The L_{10} and L_1 noise levels at Locations 5, 7, 8 and 9 are among the highest observed. This is due to being adjacent to Highway 4 and to the high volume of truck traffic, along with some influence of local street traffic at Locations 7, 8 and 9. Although Location 6 is near the Southern Pacific Railroad tracks, no train passbys were observed during the measurement intervals.

The Energy Equivalent Level, L_{eq}, ranges from 55 to 69 dBA during the rush hour, 52 to 69 dBA during the daytime, 55 to 68 dBA during the evening, and 42 to 64 dBA during the nighttime. As with the noise levels characterized by the other statistical

descriptors, the noise levels represented by the upper bound of the range for each timed period are high and are due primarily to local vehicular traffic or traffic on Highway 4.

As stated previously, 24-hour or long-term noise measurements were made at 6 of the 11 noise measurement locations. These measurements were made in order to obtain a complete statistical representation of the daily noise exposure in a community area and to show that the short-term or spot-check sample data correlate well with the variation of noise levels characteristic of the four time periods used. As with the spot-check measurements, the 24-hour or long-term noise measurements are reported in terms of A-weighted sound levels in decibels, abbreviated dBA.

The equipment used for the long-term noise evaluation at Locations #1, #3 and #4 consisted of a calibrated, precision, digital acoustical data acquisition system with a sampling rate of 60 measurements per minute. This digital data acquisition system digitizes the A-weighted noise level each second, and then stores these digitized data on a tape cassette for subsequent laboratory statistical analysis of the noise levels observed. The equipment used for the long-term noise evaluation at Locations #5, #8 and #11 is similar, but samples at the rate of 480 measurements per minute and stores the digitized data for later statistical printout. Although the digital data acquisition systems can provide information on the noise levels over a long period of time, since these units digitize the A-weighted noise level, they cannot provide information on the spectrum of noise, i.e., octave band or 1/3 octave band analyses are not possible.

Since the digital data acquisition systems operate unattended, they were usually secured to a telephone or street light-pole which locates the measuring microphone closer to nearby vehicular traffic, though somewhat higher above the ground than the microphone of the spot-check measuring system. Thus the peak

noise levels measured by the digital data acquisition system are often greater than that observed by the spot-check measurement system. However, these data do show good correlation with that obtained with the spot-check measuring system.

With the long-term measurement system, single number descriptors of the noise environment over a 24-hour time period can be obtained. The descriptors, CNEL and L_{dn} are by definition, based on a 24-hour time period and are minor variations of L_{eq}. These descriptors take into consideration the fact that people are generally more annoyed by a given sound level at night than during the day. They are determined in the same manner as L_{eq}, except that both have a 10 dB adjustment factor added to the noise levels between 10 p.m. and 7 a.m. In addition, CNEL has a 5 dB penalty applied to the noise levels between 7 p.m. and 10 p.m. Thus, depending on the noise levels occurring in a community during the evening and nighttime, CNEL and L_{dn} are often several decibels greater than $L_{eq}(24)$, the energy equivalent level over a 24-hour period.

CNEL is the noise descriptor specified in the California State Aeronautic Code for evaluation of noise impact of aircraft operations. CNEL is also specified in the California State Noise Insulation Standards for new multi-family residential dwellings. At least in California, local compliance with these standards often necessitates that community noise be specified in terms of CNEL. L_{dn} represents a slight simplification of CNEL and is the noise descriptor preferred by the U.S. EPA. For most environmental noise, L_{dn} and CNEL seldom differ by more than 1 dB. Although no long term noise descriptor levels are specified by any legislative body for operation or construction of transit systems, CNEL, L_{dn} and $L_{eq}(24)$ are reported for each long-term measurement location, and estimates are made for locations with spot-check measurements only.

Figures 3-2 through 3-7 are plots of the time history of the noise levels at the long-term measurement locations. These figures also show the date and time each survey began, as well as the values for CNEL, L_{dn} and $L_{eq}(24)$. These surveys are representative of weekday activities and generally show the decrease in noise levels during the nighttime and early morning hours which is characteristic of suburban noise dominated by transportation activities. Thus, the noise levels are the greatest during the rush hour periods, the same or somewhat lower during the daytime, still somewhat lower during the evening and considerably lower during the nighttime. Maximum levels that occurred at Locations #5 and #11 during a one hour measuring period (between 3:00 p.m. and 4:00 p.m., 19 May 1988) were unrepresentative of that locale. These hours were not considered in the determination of the 24-hour descriptors. Table 3-2 presents measured and estimated CNEL, L_{dn} and $L_{eq}(24)$ data for each of the measurement locations. Also shown in Table 3-2 are referenced community noise data from other sources.

This noise level variation over a full day has been shown to be characteristic of noise environments in a large number of urban areas in the U.S.A. and Canada. This correlation of noise measurements during different times of the day can be logically extended to the short term noise measurements, thus validating them as characteristic for the appropriate time of day and accurately characterizing the noise environment at a particular location without the need for a complete 24-hour survey. From the data obtained at locations where no 24-hour measurements were made, estimates using short-term measured data can be made of the 24-hour descriptors. These estimates are shown as a range in Table 3-2.

Near the Concord BART station on Concord Avenue and Clayton Road, the downtown commercial community is exposed to 67 to 69 dBA L_{dn}. Along Port Chicago Highway, the immediate residential community

(first row of houses along the highway) is presently exposed to 63 to 66 dBA L_{dn}. East of Port Chicago Highway 100 to 150 ft, the additional distance and shielding of the first row of houses results in a 55 to 57 dBA L_{dn}.

At distances of 125 to 150 ft from Highway 4, the residential and occasional commercial community is currently exposed to highway noise of about 67 to 69 dBA L_{dn}. At locations in Antioch overlooking Highway 4 at distances of 800 to 1,000 ft, the residential community is exposed to 56 to 58 dBA L_{dn}. According to noise measurements made by others (Reference 19) at 275 ft from Highway 4 and west of Willow Pass Road, a 66 dBA L_{dn} was measured for a new housing development project fronting a moderately travelled road parallel to the highway. This noise exposure level is consistent with the current measurements.

At a distance of 30 ft from Willow Pass Road, and east of Bailey Road, the residences and stores are now exposed to 69 to 72 dBA L_{dn}. This is due to the large amount of heavy truck traffic that services the industrial areas in West Pittsburg and Pittsburg. While these values represent levels at the residences closest to the road, noise further from the road is still relatively high.

Along the SPT right-of-way in Pittsburg, current rail traffic is minimal, and noise exposure levels were measured to be 62 to 65 dBA L_{dn} within 75 to 150 ft from the SPT tracks (Reference 14). In Antioch, one location had a measured exposure level of 58 dBA L_{dn} with only one train per day while at another location the dBA L_{dn} was 62 with two trains per day. Both locations were 75 ft from the tracks. For comparison, the noise exposure at 75 ft from the AT&SF rail line is 70 dBA L_{dn} for twelve trains per day in Pittsburg.

Along the initial path of the busway/HOV Alternative, there are additional residences 125 to 150 ft from the median of Highway 242. There are no recent measurements for this part of the Corridor, but measurements in 1978 (Reference 17) indicate a 60 to 65 dBA L_{dn} at 200 ft from the highway. It is reasonable to expect that current noise exposure is now in the range of 68 to 70 dBA L_{dn} at 150 ft from this highway.

The traffic volume on Port Chicago Highway is currently moderate, but based on projected population growth for the Corridor communities and surrounding areas and an anticipated widening of the roadway, a significant increase in traffic volume is expected by the year 2000 for Port Chicago Highway. Therefore, noise levels are also expected to increase along this segment of the alignment. Traffic on Highway 4 is expected to double by the year 2000, thereby exceeding its carrying capacity during peak hour periods. Projected average vehicle speeds at that time are reduced significantly, which would tend to balance the resulting increase in noise due to a larger volume of traffic.

A buyout of the SPTC by another major rail line is currently a viable possibility. Given the potentially fluid status of the SPTC situation, this part of the LRT Alternative, of all the Alternatives, has the greatest possibility for a substantial change in the future ambient noise environment.

TABLE 3-1 ENVIRONMENTAL NOISE LEVELS MEASURED MAY 9 THROUGH 12, 18 AND 19, 1988 BY WIA AT LOCATIONS ALONG THE PROPOSED BART PITTSBURG-ANTIOCH CORRIDOR

			Noise Levels - dBA					
Location Number	Time of Day	Date (May 1988)	L_{99}	L_{90}	L_{50}	L_{10}	L_1	L_{eq}
1	Rush Hour	10	54	56	61	68	73	64
	Day	10	51	52	59	67	72	63
	Evening	9	51	52	56	65	69	61
	Night	10	49	49	50	53	64	53
2	Rush Hour	10	43	46	52	58	67	56
	Day	10	39	42	47	57	68	55
	Evening	10	44	45	47	54	71	56
	Night	10	39	40	41	44	48	42
3	Rush Hour	10	48	53	61	65	70	62
	Day	10	38	44	56	63	73	61
	Evening	9	47	49	56	63	66	58
	Night	11	44	45	47	55	65	53
4	Rush Hour	10	56	61	66	70	77	68
	Day	10	47	55	66	72	81	69
	Evening	10	56	60	65	71	77	68
	Night	11	48	53	59	68	76	64
5	Rush Hour	10	62	65	68	71	77	69
	Day	10	58	62	67	72	77	69
	Evening	10	55	60	65	69	78	67
	Night	10	51	54	60	64	70	61
6	Rush Hour	10	44	46	50	60	65	55
	Day	10	43	44	47	53	65	53
	Evening	10	44	45	49	58	65	55
	Night	10	44	46	49	52	58	50

Location Number	Time of Day	Date (May 1988)	Noise Levels - dBA					
			L_{99}	L_{90}	L_{50}	L_{10}	L_1	L_{eq}
7	Rush Hour	11	58	62	64	68	72	65
	Day	11	54	59	63	69	75	66
	Evening	11	56	60	63	68	74	65
	Night	11	51	54	59	64	69	61
8	Rush Hour	11	56	59	64	70	75	67
	Day	11	52	55	60	68	76	69
	Evening	11	53	56	61	68	73	65
	Night	11	47	49	54	62	70	58
9	Rush Hour	11	58	61	64	67	72	65
	Day	11	51	58	62	70	79	68
	Evening	11	55	61	65	69	77	67
	Night	12	49	52	59	65	73	62
10	Rush Hour	11	50	52	55	59	66	57
	Day	11	46	48	51	55	61	52
	Evening	11	47	50	52	57	66	55
	Night	11	40	43	48	54	62	51

TABLE 3-2 COMMUNITY NOISE EXPOSURE LEVEL AT MEASUREMENT SITES FOR PITTSBURG-ANTIOCH CORRIDOR

LOCATION NUMBER	ADDRESS	$L_{eq(24)}$ (dBA)	L_{dn} (dBA)	CNEL (dBA)	REFERENCE NUMBER*	MAJOR NOISE SOURCE	APPROXIMATE DISTANCE OF SOURCE (ft)
1	Bacon Street (near Mt. Diablo Hospital) Concord	61	65	66	--	Port Chicago Highway	80
2	3165 Claudia Street Concord	51-53	55-57	56-58	--	Port Chicago Highway	200
3	Port Chicago Highway near Esparanza Drive Concord	62	65	66	--	Port Chicago Highway	100
4	Willow Pass Road near Alberts Avenue West Pittsburg	67	72	72	--	Willow Pass Road	30
5	Frontage Road near Los Medanos Elementary School Pittsburg	64	68	69	--	Highway 4	150
6	Carpino Avenue in front of St. Mark Missionary Baptist Church, Pittsburg	51-53	55-57	56-58	--	Highway 4 Local Traffic SPRR	2,000 20 300
7	2201 San Jose Drive Antioch	63-65	67-69	68-70	--	Highway 4	150
8	Corner of G Street and Drake Street Antioch	66	69	70	--	Highway 4 Local Traffic	200 20
9	On Lincoln near East Tregallas Road Antioch	64-66	68-70	69-71	--	Highway 4 Tregallas Road	200 75
10	2832 Patricia Avenue Antioch	53-55	56-58	57-59	--	Highway 4 Local Traffic	1,000 20
11	Gehringer Drive near Port Chicago Highway Concord	59	63	65	--	Port Chicago Highway	150
12	64 Woodview Road Pittsburg	65	69	69	14 (1986)	Downtown traffic, SPRR	120

* Locations #1-11 were measured by WIA in May 1988

TABLE 3-2 (CONTINUED)

LOCATION NUMBER	ADDRESS	$L_{eq(24)}$ (dBA)	L_{dn} (dBA)	CNEL (dBA)	REFERENCE NUMBER	MAJOR NOISE SOURCE	APPROXIMATE DISTANCE OF SOURCE (ft)
13	68 Russell Drive Antioch	56	58	58	14 (1986)	ATSF Interstate 680	140 3,100
14	301 West 13th Street Pittsburg	64	70	70	14 (1986)	ATSF SPRR	120 760
15	620 Gary Avenue Antioch	60	62	62	14 (1986)	SPRR Highway 4	100 670
16	901 Carpino Avenue Pittsburg	59	62	62	14 (1986)	SPRR ATSF	100 2,000
17	Claudia Drive and Jerilynn Drive Concord	--	--	57	15 (1987)	Port Chicago Highway	220
18	Hemlock Avenue near Birch Avenue Concord	60-62	--	--	17 (1979)	Local traffic Highway 242	45 575
19	Hickory Drive near Birch Avenue Concord	60-66	--	--	17 (1979)	Local traffic Highway 242	25 200
20	Upland Drive near Birch Avenue Concord	57	--	60	17 (1979)	Local traffic Highway 242	25 1,000
21	2154 California Street Concord	--	--	62	17 (1979)	Local traffic Highway 242	40 1,000
22	Oakland Avenue at Atlantic Concord	65	--	--	16 (1988)	Concord Blvd. Oakland Avenue Concord BART	400 45 400
23	Adobe Place and Westwood Court Pittsburg	49	--	51	18 (1986)	Bailey Road Highway 4	475 1,750
24	North of Evora Road West Pittsburg	58	60	--	19 (1986)	Highway 4	690
25	North of Evora Road West Pittsburg	64	66	--	19 (1986)	Highway 4	360

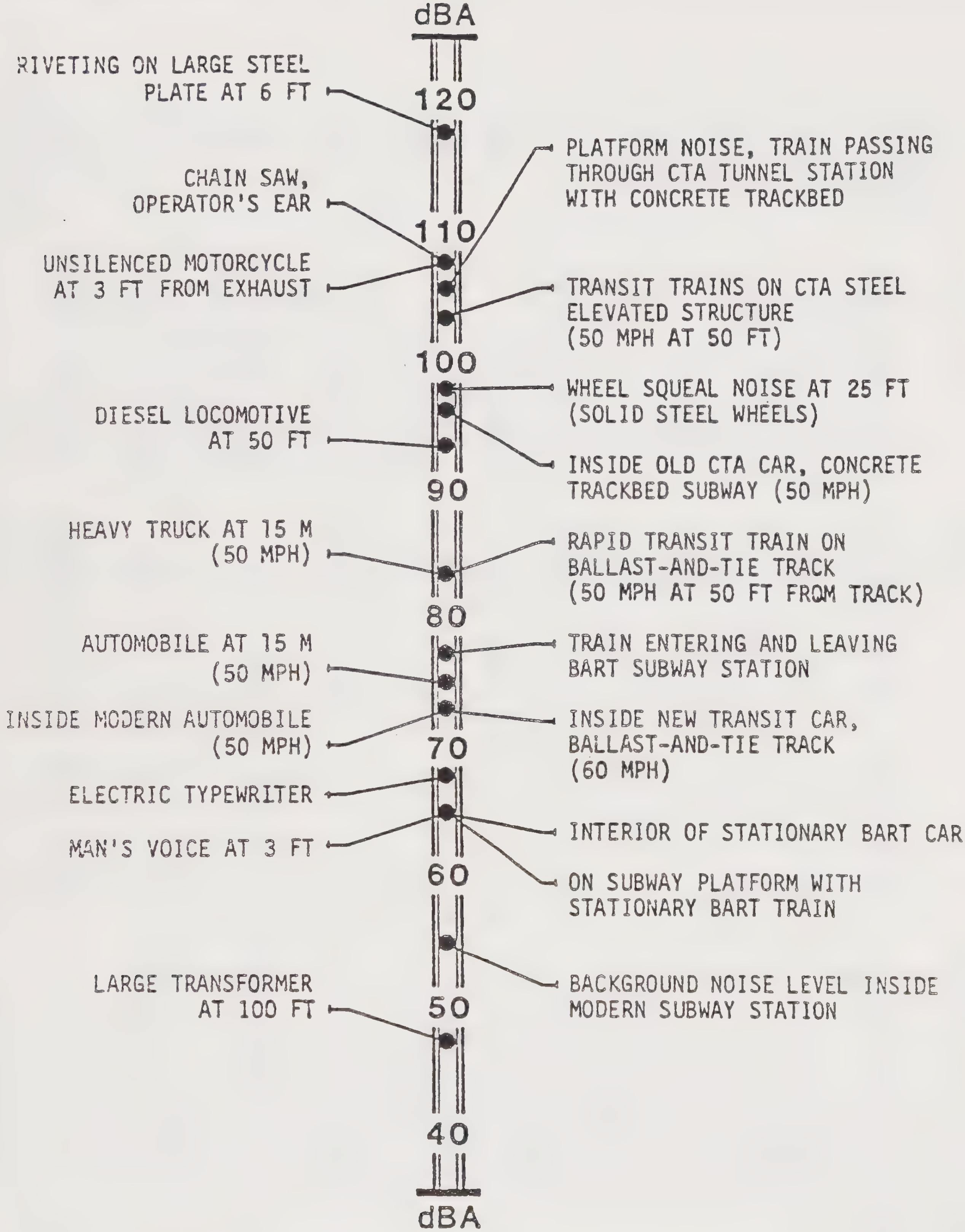

FIGURE 3-1 TYPICAL NOISE LEVELS

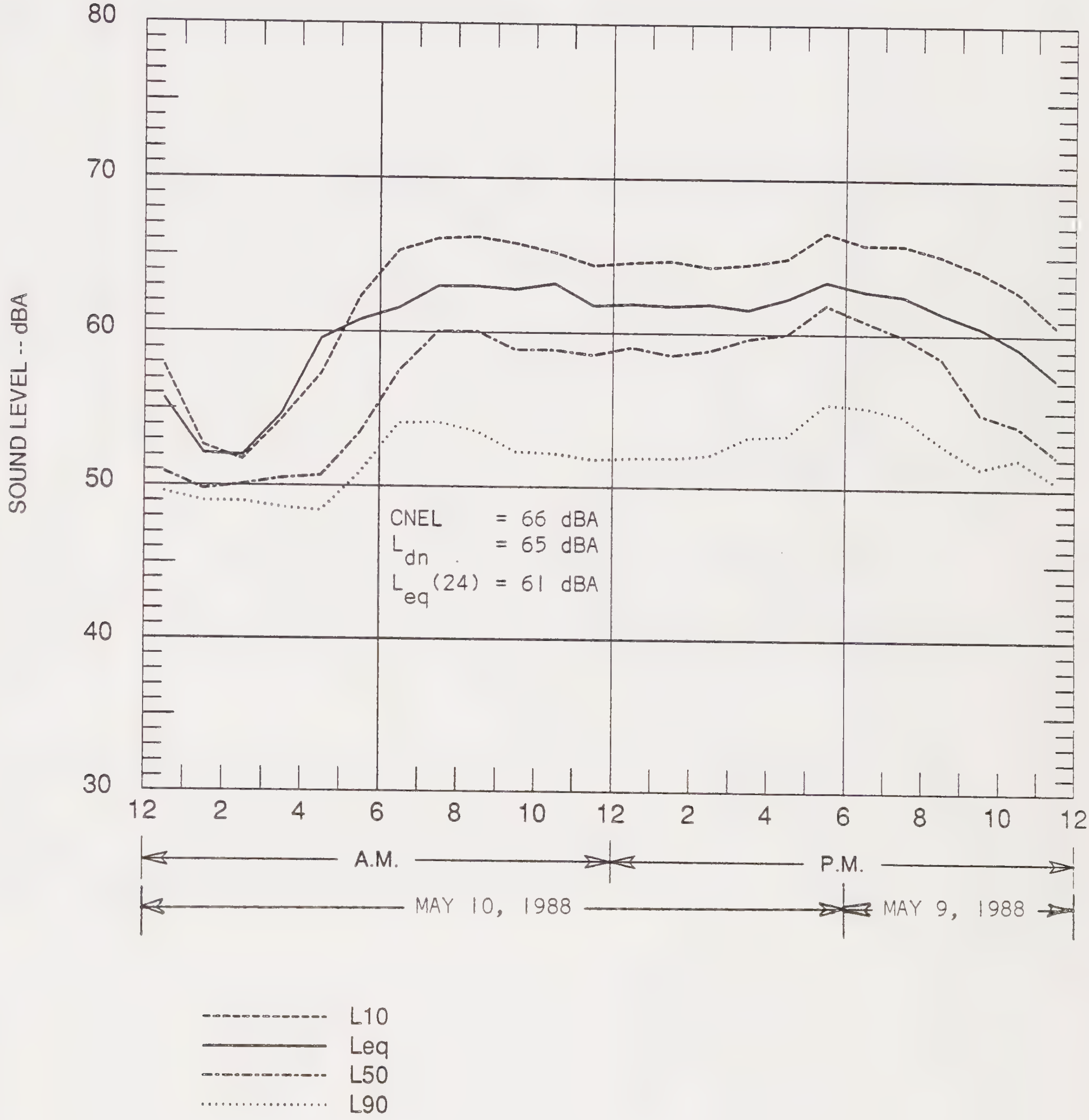

FIGURE 3-2 TIME HISTORY OF THE HOURLY NOISE LEVELS MEASURED OVER A 24-HR PERIOD AT LOCATION #1 (ON BACON STREET NEAR MT. DIABLO HOSPITAL)

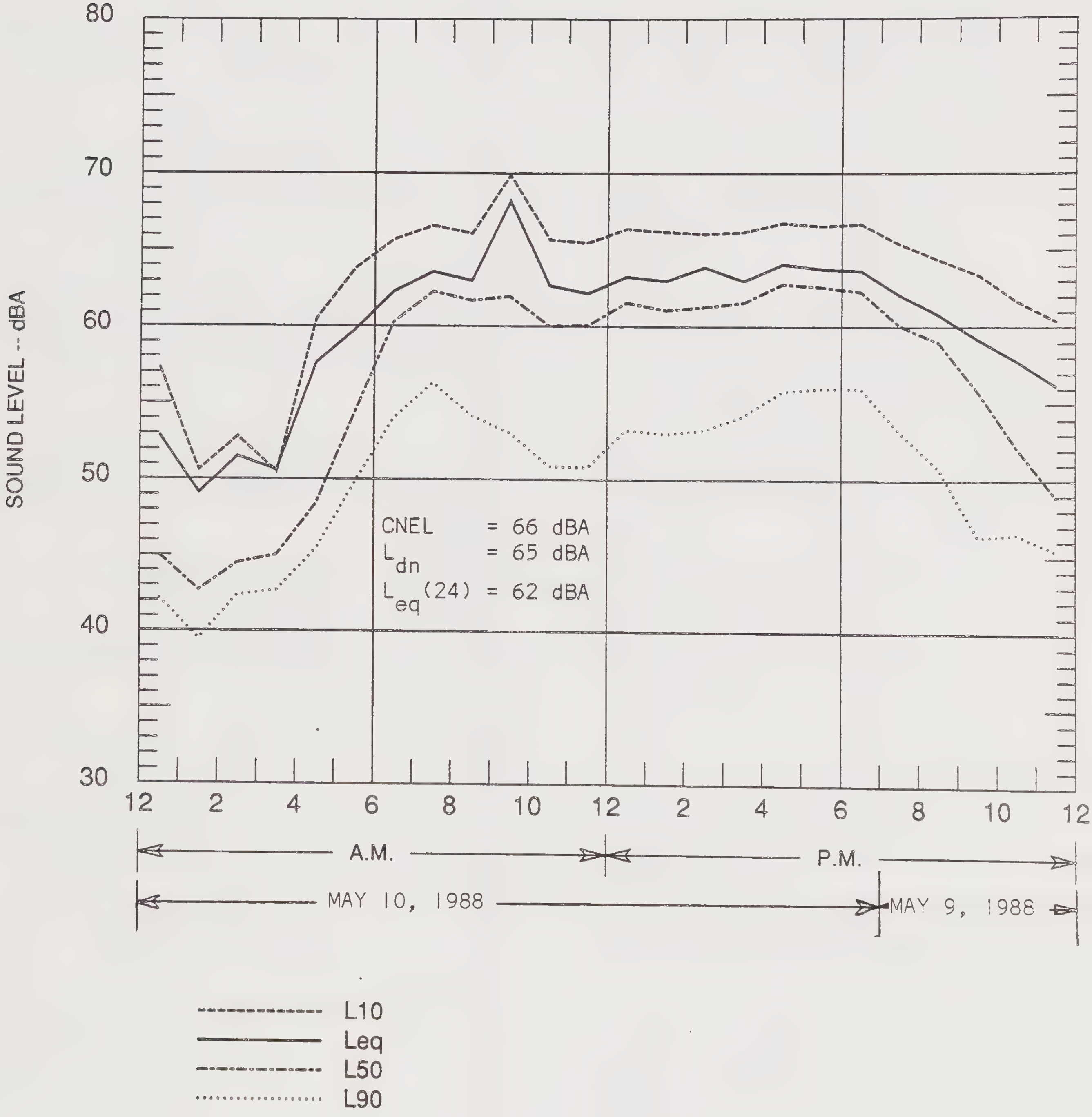

FIGURE 3-3 TIME HISTORY OF THE HOURLY NOISE LEVELS MEASURED OVER A 24-HR PERIOD AT LOCATION #3 (100 FEET FROM PORT CHICAGO HWY)

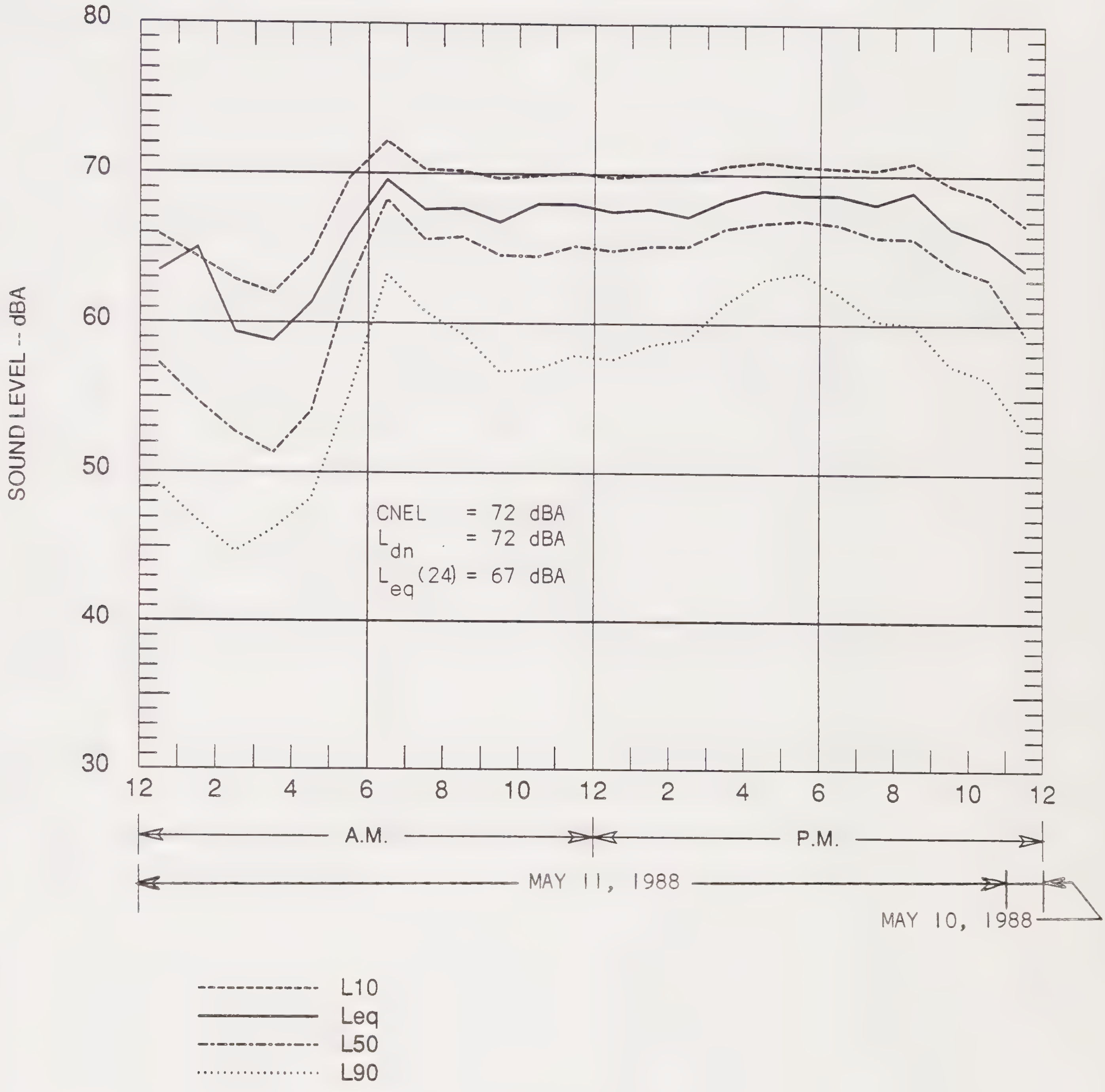

FIGURE 3-4 TIME HISTORY OF THE HOURLY NOISE LEVELS MEASURED OVER A 24-HR PERIOD AT LOCATION #4 (WILLOW PASS ROAD AND ALBERTS)

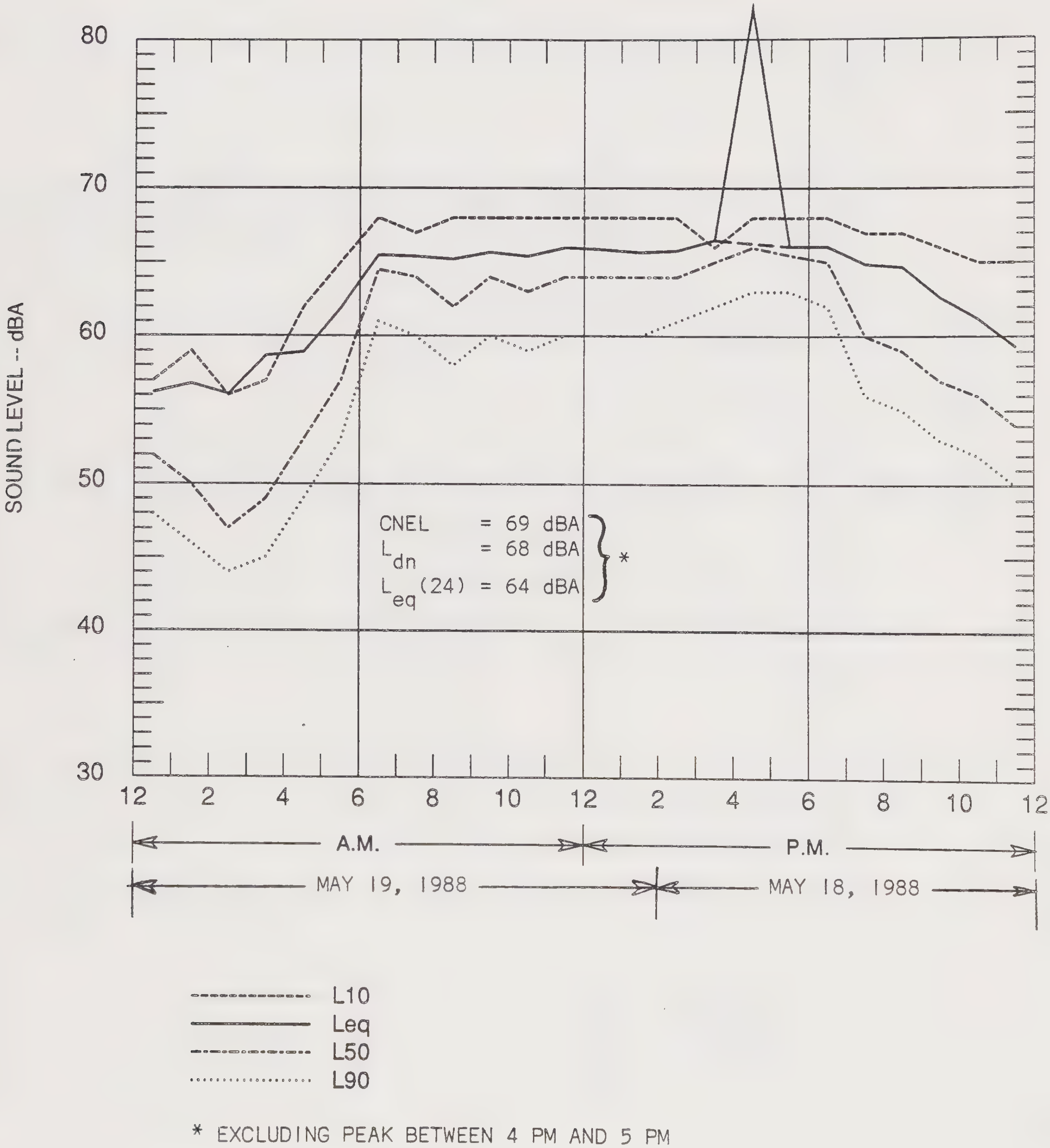

FIGURE 3-5 TIME HISTORY OF THE HOURLY NOISE LEVELS MEASURED OVER A 24-HR PERIOD AT LOCATION #5 (150 FEET FROM HWY 4 NEAR LOS MEDANOS ELEMENTARY SCHOOL)

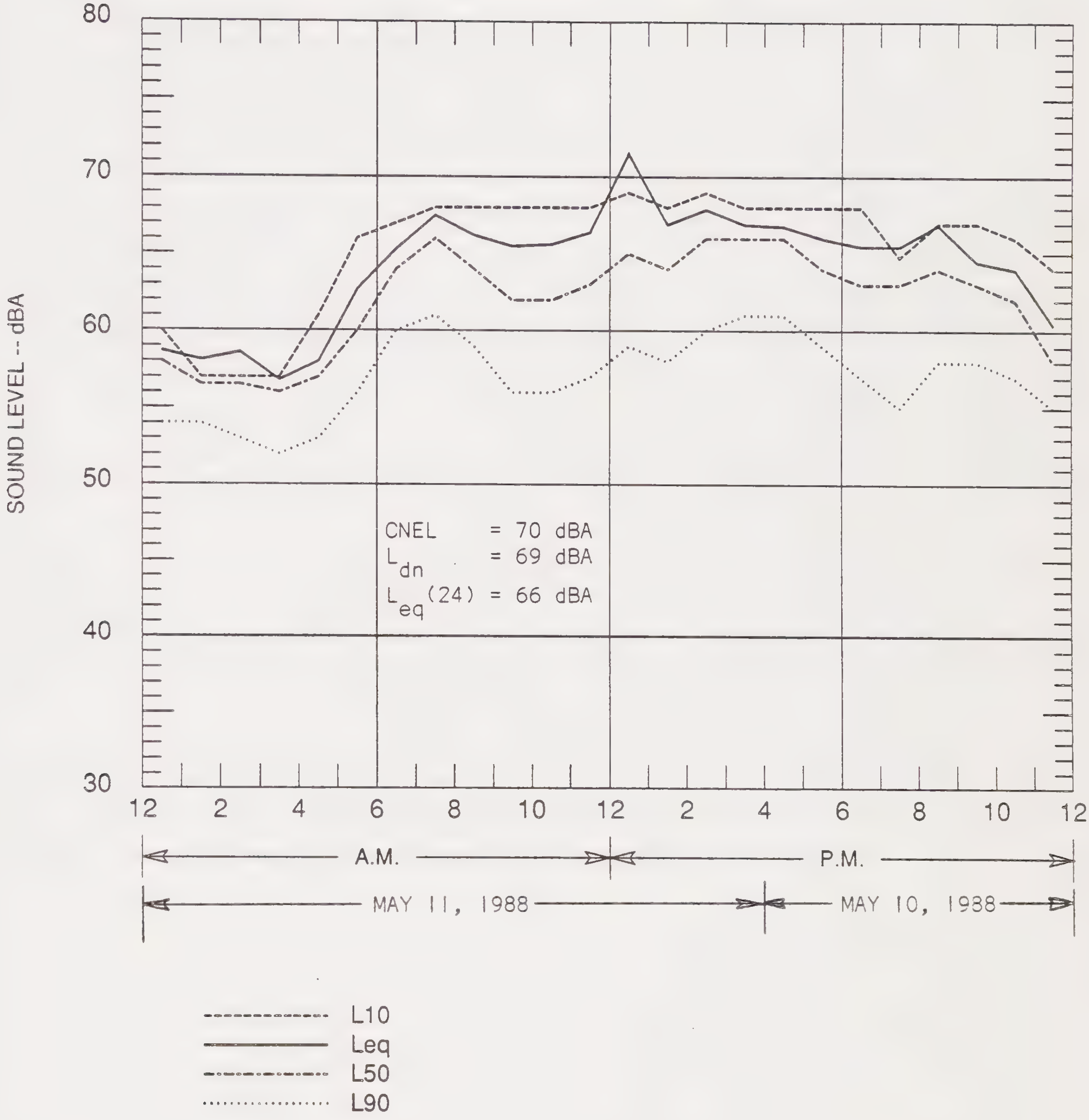

FIGURE 3-6 TIME HISTORY OF THE HOURLY NOISE LEVELS MEASURED OVER A 24-HR PERIOD AT LOCATION #8 (ON G STREET NEAR DRAKE AND 100 FEET FROM HWY 4 OVERPASS)

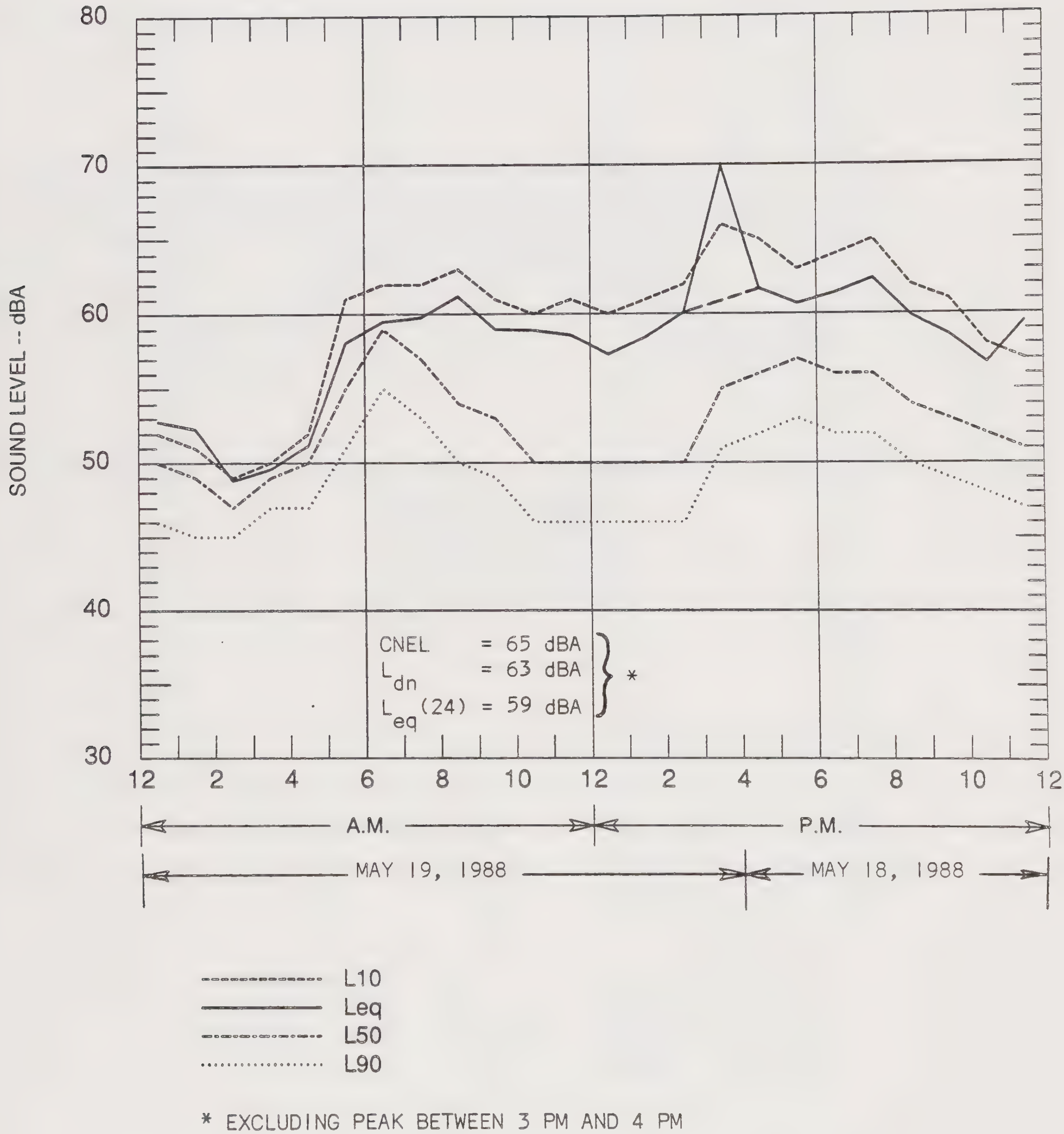

FIGURE 3-7 TIME HISTORY OF THE HOURLY NOISE LEVELS MEASURED OVER A 24-HR PERIOD AT LOCATION #11 (150 FEET FROM PORT CHICAGO HWY AVE. ON GEHRINGER DR.)

4. EXISTING VIBRATION LEVELS

The perception of vibration by people has been discussed extensively in the literature, however, most of the criteria are based on the results obtained from steady-state sinusoidal vibration excitation in laboratory environments. Relatively little information is available on the response of humans to low level random vibration or to transient vibration levels. Recently more information on this type of vibration has been obtained from the results of measurements and subjective evaluations of transit train vibration in Toronto, Washington, D.C., Chicago, San Francisco, Atlanta and Pueblo, Colorado (The Transportation Test Center).

A number of scales for evaluating the effect of vibration on man have been devised. Units such as Pal and Trem have been presented for establishing scales of response to vibration similar to the A-weighted sound level or the various loudness scales which have been used for the determination of subjective response to noise levels. None of the scales have been widely accepted in evaluating human response to vibration levels and, in general, the criteria for response are presented as charts with ranges of response as a function of vibration frequency.

As with the subjective response to noise, the human sensitivity to vibration varies with frequency. Therefore, the frequency may be taken into consideration in assessing annoyance due to vibration. However, a number of studies have indicated that at frequencies above approximately 12 to 16 Hz, sensitivity to vibration is primarily determined by the velocity amplitude and is relatively independent of frequency. Since the frequency range of significant ground-borne vibration from transit trains is typically above 12 Hz and human sensitivity is approximately

independent of frequency over this range, it is appropriate to present vibration criteria and data in terms of "overall" unweighted velocity level. Reference documents are contained in the Bibliography for additional information on impact of vibration on people. Based on the studies performed directly relating to ground-borne vibration from rail transit systems, overall vibration velocity levels below 69 dB (re: 1 micro-in/sec) are normally imperceptible to the average person.

For this survey, the vibration level data were taken simultaneously with, and at the same locations as, the short-term sound level data. Vibration acceleration was measured using a piezoelectric accelerometer, with a signal recorded on one channel of the data tape recorder. The data was analyzed to obtain a single-number (overall) unweighted velocity level. This was done using an electronic integrator.

The weighted vibration velocity levels obtained in this manner were statistically analyzed to obtain the same statistical parameters used to describe the existing noise levels; L_{99}, L_{90}, L_{50}, L_{10}, L_{1}, and L_{eq}.

The existing exterior vibration sources include automobiles, trucks, buses, freight trains, nearby mechanical equipment, and on a local scale, pedestrians. Most of the vibration sources, except stationary mechanical equipment operating continuously, create transient vibration levels. The observed level of vibration at a particular location is the summation of the vibrations created by all the various sources, near and far. This is analogous to ambient community noise which represents the summation of many noise sources.

Table 4-1 presents a complete tabulation of the statistical analysis of the weighted vibration velocity levels observed at each measurement site. In general those locations with the highest noise levels also have the highest vibration levels and vice versa, since in most cases, trucks and buses which produce high noise levels also produce high vibration levels. However, this correlation is not always true since airplanes, motorcycles, and some cars can produce high noise levels but not necessarily high vibration levels.

The L_1** values measured in the current study never reach and are considerably below 69 dB at all of the specified measurement locations. The L_1 (meaning for approximately 6 seconds out of each 10 minutes) vibration levels near Highway 4 (at a distance of 150 ft) and Willow Pass Road (at a distance of 30 ft) range from 49 to 60 dB during the day. The higher vibration level corresponds to peak hour traffic. In general, although imperceptible, these are relatively high levels of community vibration and reflect the presence of heavy truck traffic along these routes. However, the vibration levels are typical of commercial and residential areas near heavily travelled streets and comparable to levels in other suburban areas of larger cities (e.g., Los Angeles).

Vibration levels along Port Chicago Highway are slightly lower than 69 dB with an L_1 range of 38 to 57 dB (at a distance of 80 to 100 ft) during the course of the day. This reflects the lack of heavy truck traffic, although there are presently two bus lines running on the highway. Within the residential community adjacent to Port Chicago Highway the vibration levels are even lower.

** The vibration velocity level exceeded one percent of the time, representing occasional maximum or "peak" vibration level.

Due to the relative lack of trains using the SPT tracks, no measurements were made of vibration from freight trains on the tracks in the Corridor area. However, based on measurements made on other projects by WIA, in particular one set of measurements made adjacent to the AT&SF tracks in nearby Oakley, the overall vibration velocity levels were 79 dB for locomotives at 75 ft from the tracks and 75 dB for freight cars at the same distance. Given the close proximity of the measurement location for this data and other supporting data at similar locations in the San Francisco Bay area, similar vibration levels for freight traffic are expected for the SPT alignment in the Corridor. For the residential community in Antioch, which is within 75 to 100 ft of the SPT tracks, the vibration from freight trains should be clearly perceptible under existing conditions.

TABLE 4-1 ENVIRONMENTAL VIBRATION LEVELS MEASURED MAY 9 THROUGH 12, 18 AND 19, 1988 BY WIA AT LOCATIONS ALONG THE PROPOSED BART PITTSBURG-ANTIOCH CORRIDOR

Location Number	Time of Day	Date (May 1988)	Vibration Velocity Levels (dB re 1 micro in/sec) L_{99}	L_{90}	L_{50}	L_{10}	L_{1}	L_{eq}
1	Rush Hour	10	37	39	42	46	57	46
	Day	10	35	38	42	47	57	46
	Evening	9	37	39	43	46	51	44
	Night	10	31	32	36	40	44	37
2	Rush Hour	10	28	29	33	42	56	42
	Day	10	25	28	34	43	57	42
	Evening	10	19	21	26	34	47	32
	Night	10	24	25	26	30	44	32
3	Rush Hour	10	23	27	35	42	53	40
	Day	10	21	24	31	39	48	36
	Night	11	16	18	21	28	38	26
4	Rush Hour	10	33	39	44	50	60	48
	Day	10	27	33	40	48	59	46
	Evening	10	30	34	40	48	56	45
	Night	11	25	27	34	44	49	39
5	Rush Hour	10	37	39	43	47	54	46
	Day	10	38	40	45	51	55	47
	Evening	10	42	53	45	39	34	31
	Night	10	26	29	37	43	48	39
6	Rush Hour	10	32	33	37	40	49	39
	Day	10	33	35	39	43	52	41
	Evening	10	32	33	36	40	52	42
	Night	10	31	32	34	37	42	36

Location Number	Time of Day	Date (May 1988)	Noise Levels - dBA L_{99}	L_{90}	L_{50}	L_{10}	L_{1}	L_{eq}
7	Rush Hour	11	36	39	43	51	57	47
	Day	11	35	39	46	54	59	50
	Evening	11	32	35	41	49	55	45
	Night	11	27	30	35	45	55	43
8	Rush Hour	11	37	41	46	52	58	49
	Day	11	35	39	46	52	57	48
	Evening	11	31	35	42	50	57	49
	Night	11	28	29	35	44	52	44
9	Rush Hour	11	30	34	39	45	53	42
	Day	11	32	35	41	47	60	47
	Evening	11	29	31	37	42	49	39
	Night	12	22	25	31	39	49	37
10	Rush Hour	11	21	23	26	33	40	30
	Day	11	24	26	30	35	44	33
	Evening	11	21	22	26	34	45	32
	Night	11	19	21	24	30	35	27

5. NOISE AND VIBRATION CRITERIA

5.1 General

The basic goals of noise and vibration criteria as they apply to a new transit line are to: (1) minimize the adverse impact of system operation on the community by controlling transmission of noise and vibration to adjacent properties, and (2) provide noise and vibration control consistent with economic constraints and appropriate technology.

A wayside community noise impact criterion provides a basis from which to determine the type and extent of noise reduction measures necessary to avoid annoyance in the community. The wayside noise criteria must be related to the type of activity taking place in the building or community and the ambient noise levels in the absence of transit system noise. Obviously, a passby noise level of a given magnitude is more objectionable in a quiet residential area at night than in a busy commercial area during the day.

The typical existing ambient or background noise and vibration levels vary significantly from one type of community to the next. Therefore, it is necessary to make a judgment as to the nature of the community in which the transit system is to be located before determining the appropriate criterion for permissible noise or vibration levels from the transit system in that community.

Table 5-1 indicates the five generalized categories of wayside areas into which the communities along transit corridors can be categorized for the purpose of assigning appropriate noise and vibration criteria. The table indicates the description of the areas and the normal expected range of ambient noise levels. These categories and noise levels are based in part, on the

information developed from several studies of rail transit corridor environments along with data presented in the 1974 U.S. Environmental Protection Agency (EPA) document, "Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety," usually referred to as the "Levels Document" and other field data obtained in many community areas in the U.S.A. and Canada.

The categories defined in Table 5-1 are used in defining appropriate design criteria. The land use or area categories are are similar to those used by several transit properties and presented in the APTA Publication, "Guidelines for Design of Rapid Transit Facilities." In most cases, experience with the new systems now in operation and extensions of older systems has indicated that these categories and the associated criteria provide for adequate results and most of the neighbors of the transit facility find the noise and vibration acceptable.

There are two basic types of noise criteria, the first is based on the allowable single event maximum noise level and the second on some type of noise exposure limit. The first set of criteria are those contained in Section 2-7.6 of the APTA (American Public Transit Association) publication, "Guidelines for Design of Rapid Transit Facilities." The second set of criteria are those contained in Section D of the UMTA (Urban Mass Transportation Administration) publication, "Guidelines for Preparing Environmental Assessments."

Traditionally, criteria have been specified only for the control of airborne and ground-borne noise. More recently, criteria for ground-borne vibration in terms of single number vibration velocity level (re: 1.0 micro-in/sec) have been developed and applied to new rail transportation systems to assist in avoiding significant impacts and complaints relative to feelable ground-borne vibration.

Since there are only very short sections of subway as part of the alignment, there should be no perceptible ground-borne noise, although ground-borne vibration might still be perceptible. Ground-borne noise is a rumbling noise perceived inside a building which is due to the radiation of noise from the vibrating floor and sometimes walls during a train passby. For at-grade or aerial structure operations airborne noise will virtually always predominate the ground-borne noise and thus ground-borne noise criteria are not presented.

5.2 Local Guidelines

The State of California has enacted a number of laws intended to control noise. None of these laws directly affect the Pittsburg-Antioch Corridor Project. The California Administrative Code, Title 24, does indirectly establish a noise exposure limit standard for airborne noise from rail transit vehicle operation.

The Cities of Antioch, Concord, and Pittsburg and Contra Costa County have complied with the requirements of the California Government Code Section 65302(g) by adopting a Noise Element to their General Plan. These Noise Elements, some of which are currently under revision, contain specific guidelines relevant to the Pittsburg-Antioch Corridor Project. The purpose of the noise criteria in the Noise Elements is to assist in developing compatible land use for new building projects and consequently do not apply specifically to transit vehicle operation during revenue service. However, the criteria can be considered to be community goals that are an indication of a particular community's opinion concerning noise impact.

The Noise Elements of the Pittsburg-Antioch Corridor are supported by Table 5-1. These elements generally state that community noise exposure below 60 dBA CNEL is acceptable for residences including other noise sensitive receptors (e.g. schools and hospitals). An

unacceptable CNEL is over 70 dBA, while this value is an acceptable maximum for commercial buildings. As an example of the "land-use" planning, noise criteria, the criteria contained in the City of Concord Noise Element is shown in Figure 5-1. The criteria shown is typical for the other city and County Noise Elements.

As of the date of this study, only the City of Pittsburg, of the governmental bodies for the potentially affected communities, has enacted a specific Noise Control Ordinance. There are no numerical levels specified, instead only qualitative criteria relating to "public nuisance" or disturbing the peace. Pittsburg Ordinance does contain limits on the time of day for operation of heavy construction equipment (e.g. pile drivers). Of the other communities involved in the Corridor, the general approach to noise complaints from citizens are also handled on a basis of nuisance. Therefore, there are no specific local ordinances which set numerical criteria for maximum noise emission levels.

5.3 APTA Guidelines

Section 2-7.6 of the APTA publication, "Guidelines for Design of Rapid Transit Facilities" presents guidelines for noise in transit corridor communities. These guidelines, as they apply to the operations of BART and LRT transit trains on the Alternative Alignments for the Pittsburg-Antioch Corridor, are presented in Tables 5-2 and 5-3. A maximum single event noise level refers to the peak level which occurs during a train passby. This is not to be confused with a single event noise exposure level (SENEL).

WIA assisted in preparation of the APTA Guidelines, and believes they are appropriate for application to this new alignment. In certain situations these guidelines are more restrictive than the noise exposure type guidelines for evaluating impact. It should

be emphasized that the APTA Guidelines are to be used as a design tool to determine if mitigation measures are necessary to avoid impact. Noise exposure guidelines can be used to assess impact, but due to their cumulative nature are not really useful as a design tool.

Since the Corridor rail alignment will be primarily at-grade and aerial, many of the ancillary facilities associated with fixed rail facilities for subway will not be part of the proposed system. However, substations will still be a necessary part of the proposed system. Transformer hum and cooling fan noise are the two main noise sources from substations. Since the alignment will be primarily at-grade and aerial, it is assumed that the substations will also be located at-grade.

Table 5-4 presents the design goal for substation noise by the type of community. This table is adapted from the APTA Guidelines for fixed facilities, specifically modified to apply only to substation noise.

5.4 Noise Exposure Criteria

The U. S. Department of Transportation (DOT) and the Urban Mass Transportation Agency (UMTA) of DOT do not have any specific noise and vibration guidelines or criteria for rapid transit systems. Their activity in this area is limited to review of environmental impact statements and review of design features to assure compliance with the environmental impact statement requirements and standard industry practices.

However, UMTA does have some general guidelines for evaluating the significance of noise impacts contained in "Guidelines for Preparing Environmental Assessments," UMTA C5620.1. These guidelines indicate that noise impacts are generally not

<u>significant</u> (1) if no noise-sensitive sites are located in the project area, and (2) if increases in the equivalent noise levels (L_{eq}) with implementation of the project are expected to be $\leq$3 dBA at noise sensitive locations and the proposed project would not result in violations of noise ordinances or standards. Noise impacts are <u>possibly significant</u> if increases in equivalent noise levels (L_{eq}) with implementation of the project are expected to be no greater than 5 dBA. Determination of significance must consider existing noise levels and the presence of noise-sensitive sites. Noise impacts are <u>generally significant</u> if the proposed project would cause (1) noise standards or ordinances to be exceeded, (2) an increase in the equivalent noise level (L_{eq}) of 6-10 dBA in built-up areas, and (3) an increase in the equivalent noise level (L_{eq}) of 10 dBA.

5.5 Vibration Criteria

Table 5-5 presents the appropriate criteria for the maximum ground-borne vibration for various types of residential buildings in terms of vibration velocity level (re: 1.0 micro-in/sec). The criteria apply to the vertical vibration of floor surfaces within the buildings. As with the noise criteria, there are some types of buildings for which design criteria for ground-borne vibration should be applied, regardless of community area category. Table 5-6 presents design goals based on generally acceptable levels of transient ground-borne vibration levels in occupied spaces of various types of buildings and occupancies.

Ground-borne vibration which complies with these design criteria will not be imperceptible in all cases; however, the level will be sufficiently low so that no significant intrusion or annoyance should occur. In most cases, there will be vibration from street traffic, other occupants of a building, or other sources, which will create intrusion that is equivalent or greater in level than vibration from the transit train passbys.

TABLE 5-1 GENERAL CATEGORIES OF COMMUNITIES ALONG RAIL SYSTEM CORRIDORS

Area Category	Area Description	Typical (Average or L_{50}*) Ambient Noise Level-dBA	Typical Day/Night Exposure Levels-L_{dn}
I	Low Density urban residential, open space park, suburban residential or quiet recreational area. No nearby highways or boulevards.	40-50 - day 35-45 - night	Below 55
II	Average urban residential, quiet apartments and hotels, open space, suburban residential, or occupied outdoor areas near busy streets.	45-55 - day 40-50 - night	50-60
III	High Density urban residential, average semi-residential/ commercial areas, parks, museum, and non-commercial public building areas.	50-60 - day 45-55 - night	55-65
IV	Commercial areas with office buildings, retail stores, etc., primarily daytime occupancy. Central Business Districts.	60-70	Over 60
V	Industrial areas or Freeway and Highway Corridors.	Over 60	Over 65

*L_{50} is the long-term statistical median noise level.

TABLE 5-2 APTA GUIDELINES FOR MAXIMUM AIRBORNE NOISE FROM TRAIN OPERATIONS*

Community Area Category	Maximum Single Event Noise Level: Single Family Dwellings	Multi-Family Dwellings	Commercial Buildings
I Low Density Residential	70 dBA	75 dBA	80 dBA
II Average Residential	75	75	80
III High Density Residential	75	80	85
IV Commercial	80	80	85
V Industrial/Highway	80	85	85

*These criteria are generally applicable at the nearside of the nearest dwelling or occupied building under consideration or at 50 ft from the track centerline, whichever is closer.

TABLE 5-3 APTA GUIDELINES FOR MAXIMUM AIRBORNE NOISE FROM TRAIN OPERATIONS NEAR SPECIFIC TYPES OF BUILDINGS*

Building or Occupancy Type	Maximum Single Event Noise Level
Amphitheatres	65 dBA
"Quiet" Outdoor Recreation Areas	70 dBA
Concert Halls, Radio and TV Studios	70 dBA
Churches, Theatres, Schools, Hospitals, Museums, Libraries	75 dBA

*These criteria are generally applicable at the nearside of the nearest dwelling or occupied building under consideration or at 50 ft from the track centerline, whichever is closer.

TABLE 5-4 APTA GUIDELINES FOR NOISE FROM SUBSTATIONS*

Community Area Category		Maximum Noise Level Design Goal
I	Low Density Residential	35 dBA
II	Average Residential	40
III	High Density Residential	45
IV	Commercial	50
V	Industrial/Highway	60

*The design goal noise levels should be applied at 50 ft from the substation or should be applied at the set back line of the nearest buildings or occupied area, whichever is closer.

TABLE 5-5 RECOMMENDED GUIDELINES FOR MAXIMUM GROUND-BORNE VIBRATION FROM TRAIN OPERATIONS*

Community Area Category	Maximum Single Event Ground-borne Vibration Velocity Level (dB re 10^{-6} in/sec)		
	Single Family Dwellings	Multi-Family Dwellings	Hotel/ Motel Buildings
I Low Density Residential	70	70	70
II Average Residential	70	70	75
III High Density Residential	70	75	75
IV Commercial	70	75	75
V Industrial/Highway	75	75	75

*Criteria apply to the vertical vibration of floor surfaces within the buildings.

TABLE 5-6 RECOMMENDED GUIDELINES FOR MAXIMUM GROUND-BORNE VIBRATION FROM TRAIN OPERATIONS*

Type of Building or Room	Maximum Single Event Vibration Velocity Level (dB re 10^{-6} in/sec)
Concert Halls and TV Studios	65
Auditoriums and Music Rooms	70
Churches and Theatres	70-75
Hospital Sleeping Rooms	70-75
Courtrooms	75
Schools and Libraries	75
University Buildings	75-80
Offices	75-80
Commercial & Industrial Buildings	75-85
Vibration Sensitive Industrial or Research Laboratory	60-70

*Criteria apply to the vertical vibration of floor surfaces within the buildings.

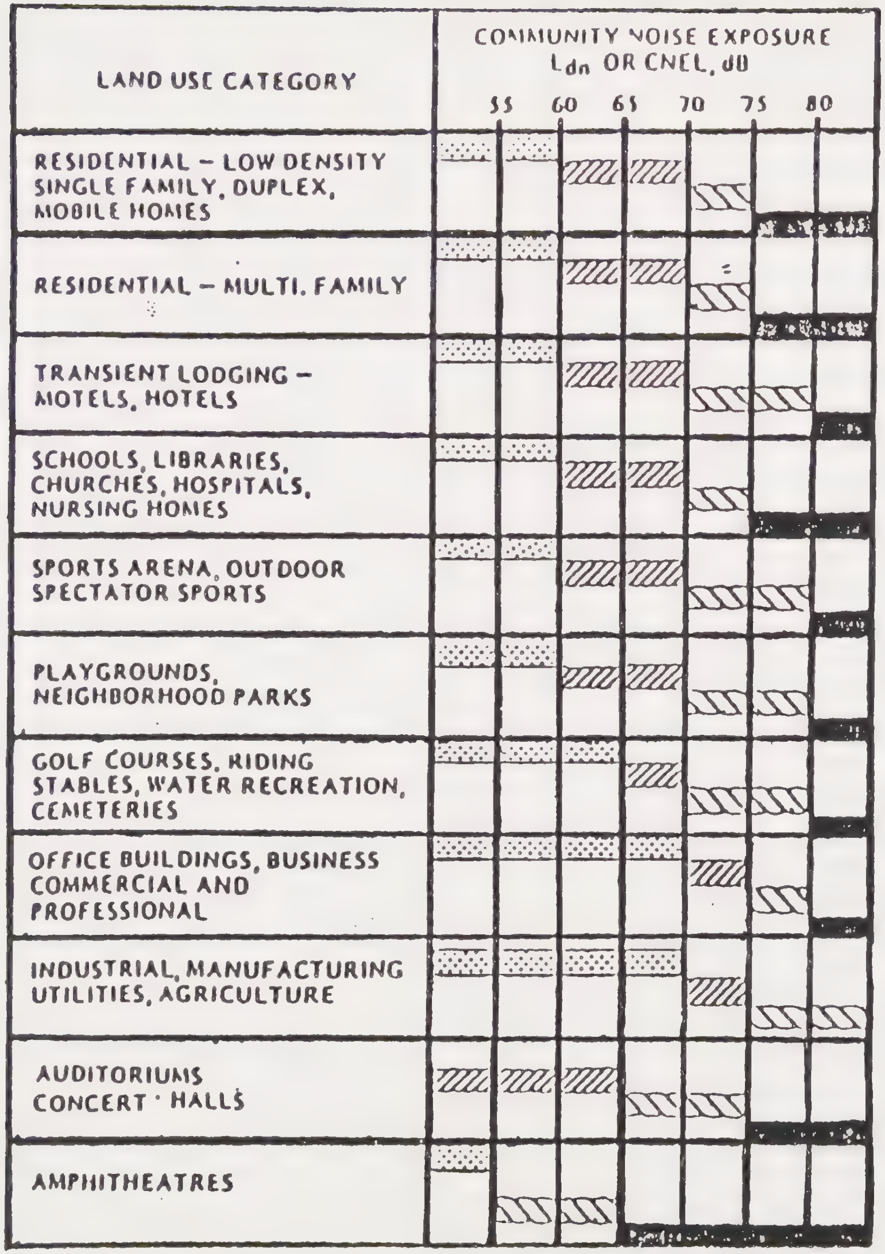

FIGURE 5-1 TYPICAL LOCAL LAND-USE PLANNING, COMMUNITY NOISE EXPOSURE CRITERIA

INTERPRETATION

NORMALLY ACCEPTABLE

Specified land use is satisfactory, based upon the assumption that any buildings involved are of normal conventional construction, without any special noise insulation requirements. Indoor and outdoor will be pleasant.

CONDITIONALLY ACCEPTABLE

New construction or development should be undertaken only after a detailed analysis of the noise reduction requirements is made and needed noise insulation features included in the design. Conventional construction, but with closed windows and fresh air supply systems or air conditioning will normally suffice. Outdoor environment will seem noisy, but tolerable.

POTENTIALLY UNACCEPTABLE

New construction or development should generally be discouraged. If new construction or development does proceed, a detailed analysis of the noise reduction requirements must be made and needed noise insulation features included in the design. Outdoor areas must be shielded.

NORMALLY UNACCEPTABLE

New construction or development should generally not be undertaken. Analysis and mitigation as discussed above will be required. Construction costs to make the indoor environment acceptable may be prohibitive and the outdoor environment may not be useable.

6. OPERATION WAYSIDE NOISE LEVELS AND IMPACT ANALYSIS FOR RAIL ALTERNATIVES

6.1 General

To provide a basis for evaluating the expected acoustical impact of BART and LRT trains operating on the various Corridor Alternative Alignments, levels of the expected wayside noise from train operations have been determined. The background information providing the basis for the expected performance is based on data measured by WIA for both BART and LRT vehicle types. Reference 9 and 10 present all of the measured baseline data used for this analysis. The predictions for BART alternatives are based on noise levels measured from BART operations. Wayside noise levels for the LRT alternatives are based on design data for the Guadalupe Corridor Light Rail Vehicle (LRV) operation. The LRV vehicle for the Pittsburg-Antioch Corridor would be similar to that to be used on the Guadalupe Corridor rail system.

The predictions of wayside noise levels to be expected from BART and LRT trains take into account the operational characteristics such as train length, speed, auxiliary equipment noise and other features which can affect the wayside noise. It should be noted that rail transit train noise is strictly a function of speed. There is no variation in the noise produced for different operating modes, i.e., acceleration, deceleration, coasting, or constant speed.

Based on recent measurements on the newly completed first segment of the Guadalupe Corridor LRT alignment, indications are that actual wayside noise are somewhat lower than anticipated by the design data. The LRT noise predictions in the current analysis should therefore be somewhat conservative. If a Guadalupe Corridor type LRT is the system selected for the Pittsburg-Antioch Corridor, further measurements to characterize actual wayside noise levels are recommended.

An important design feature which contributes to quieter operation is the use of continuous welded rail. Eliminating rail joints eliminates one of the major sources of noise in a steel wheel/rail system. Except at special trackwork locations, it has been assumed that continuous welded rail will be used along the entire alignment.

For the purpose of assessing the environmental impact of proposed rail alignments, it is sufficient to assume level terrain for the surrounding community and generally ignore any shielding offered by intervening buildings or existing sound barrier walls between the rail alignment and noise sensitive receivers. This is a conservative assumption consistent with the level of analysis at this stage of the project. A more detailed analysis should be performed in the engineering design phase of the project to determine the specific details of the noise reduction features indicated in the environmental impact analysis.

In the evaluation and control of wayside noise created by steel wheel/rail rapid transit system operations, for surface and aerial way structures, the use of low sound barrier walls at the side of the way structure has been found to be an effective means for reducing wayside noise exposure due to the transit train operations. Evaluations which have been made at several of the newest systems indicate that a substantial noise reduction, typically on the order of 7 to 10 dBA, can be achieved with sound barrier walls. The predictions which are part of this chapter include determination of the expected wayside noise level at noise sensitive locations adjacent to each alignment with the inclusion of sound barrier walls as part of the transit system facilities at those locations where a sound barrier is needed for reduction of wayside noise.

Aerial Structure Operation

For the BART and LRT alternative alignments, it has been assumed that the aerial structure will be concrete with direct fixation, resilient rail fasteners similar to those in use on existing BART aerial structure. The trackbed on the aerial structure will be concrete unlike the ballast for the at-grade section of the alignment. This will result in noise levels from train passbys that are somewhat higher for operation on aerial structure when compared to operation on at-grade ballast and tie track. This is due to the sound absorptive characteristic of the ballast and tie trackbed.

One of the noisiest modes of operation of rail rapid transit systems on older transit facilities has been operation on lightweight steel elevated or aerial structures. This type of steel structure characteristic of designs constructed in other cities in the early part of this century have direct or rigidly attached rails and produce very intense noise due to mechanical vibration of the structure as the transit trains pass by. This noise has resulted in considerable impact on the neighboring areas and buildings and is one of the factors which has resulted in the general public view that rail rapid transit systems are noisy. The noise generated by the steel aerial structure also results in high noise levels in the transit car, decreasing the quality of the environment presented to the transit system patrons.

For many years it has been known that concrete deck and all-concrete aerial structures, such as used on almost all existing BART facilities, result in much less structure radiated wayside noise and in-car noise for aerial structure operations. At transit systems such as BART, WMATA Metro and MARTA, the use of concrete aerial structures or concrete/steel structures with resilient direct fixation rail fasteners has been demonstrated to

be very effective in reducing wayside and in-car noise. The noise radiated by the mechanical vibration of the concrete or composite steel/concrete aerial structure is less than the noise radiated by the car, thus the noise produced during aerial structure operations is primarily due to the characteristics of the car. The concrete structure is so effective, in fact, that it is possible to use a low (nominally 3-1/2 to 4 ft above top-of-rail) sound barrier wall for further reduction of the wayside noise since the noise is primarily radiated from the transit car and rails. The height of the sound barrier wall necessary for a specific amount of noise reduction is related to the distance between the vehicle and the wall. The farther from the vehicle the higher the wall needs to be.

For some types of concrete/steel composite aerial structures, there is the possibility of low-frequency (<300 Hz) noise radiation, either from the plates of the steel girders, or for specific conditions, from the concrete deck. At low frequencies, the level can be as much as 15 dB higher for the steel girder structure, but because the A-weighted level is dominated by the mid-frequency components, the A-weighted level from train passbys is essentially the same for either structure. Although this low frequency radiation does not influence the A-weighted level, it does change the character of the noise, most notably after transmission to the inside of wood frame houses located near steel girder structures. This is because the walls of typical houses or apartment buildings effectively reduce the mid- and high-frequency sounds, but are relatively ineffective at reducing the low frequency components. The net result is that the train passby noise has the character of a low rumble which may be annoying to some people even if the A-weighted noise level does not exceed appropriate criteria.

The details of the final design of all sections of the aerial structure have not been determined at this time. However, if other than all concrete structures such as a concrete/steel composite aerial structure are used in special situations (e.g., long span sections, bridges), specially designed damping techniques can be used to reduce the low-frequency rumbling noise in noise sensitive areas.

In certain situations, a sound barrier wall alone is not sufficient to adequately reduce wayside noise levels in the adjacent community. Such a situation usually arises when there are residential community areas close to the alignment that are otherwise shielded from heavy surface street traffic noise by an intervening row of houses. Aerial structure operation raises the transit vehicle noise sources above the first row of houses, thereby eliminating any shielding effects. In such instances, sound absorbing material applied to the inside face of the sound barrier wall has been found to produce further reductions of wayside noise, where necessary.

The wayside noise level predictions for the aerial structure segments of the alignments do not include the effect of such sound absorption treatment. Installation of absorptive treatment to the inside face of the sound barrier wall will usually result in an additional 2 to 3 dBA reduction in wayside noise from aerial structure operation. Where additional reduction in wayside noise is needed, such areas are addressed in the discussion of each alternative alignment. The specific details and requirements of absorptive treatment and lengths of sound barrier wall sections should be addressed during engineering analysis of the alignment alternative selected for design and construction.

At-Grade Ballast and Tie Track

With ballast and tie operations, there is a small decrease in the wayside and in-car noise compared to operation on concrete aerial structure. This is due to the sound absorption provided by the porous ballast material. This means that, all other things being equal, the wayside noise levels from at-grade ballast and tie track facilities will be somewhat less when compared with noise levels at the same distance from aerial structure operation.

For maintenance reasons, typical sound barrier walls for at-grade track facilities are usually located further away from the track structure compared to aerial applications. Consequently, the barrier wall for at-grade facilities must be slightly higher (typically 5 ft above top-of-rail) for the same amount of wayside noise reduction.

The installation of sound absorbing material on the inside face of at-grade sound barrier walls has not been found to be particularly effective when used along ballast and tie sections. The reasons for this is due to the reduced effectiveness of adding more absorption in addition to that already provided by the ballast. It may be possible though to design a slightly higher wall with absorption where additional noise reduction is needed. This has yet to be tried for a system in revenue service and only minimal further reduction in wayside noise is expected.

Crossovers

The presence of switches at crossover points between two tracks is a special noise problem in itself, if standard, passive "switch frogs" are used. The standard switch has a significant gap at the crossover point that the vehicle steel wheel must pass over. The

impact caused by this gap results in substantially higher noise and vibration levels adjacent to switch locations. The presence of switches, unless specially constructed units are used, has a much greater potential for impact on the adjacent community.

Because of the substantially increased noise levels at crossover locations, such facilities should, if at all possible, be located away from residential and other noise sensitive areas. Where this is not possible, specially designed switch frogs which virtually eliminate the gap can be installed resulting in lower noise levels compared with standard switch frogs. If there is no gap at the switch frog, then the wayside noise will be essentially the same as that for train operations on standard trackwork. A switch with a "moveable point" switch frog or with a "spring loaded" frog which is normally closed would reduce the increase in wayside noise. However, it should be noted that most transit authorities have generally resisted the use of either of these switch types due to potential maintenance problems and added electronic control and monitoring systems.

6.2 Wayside Noise from Individual Train Passbys

Wayside noise levels for individual train passbys, during "peak hour" period, were predicted for specific buildings or groups of buildings using the previously discussed methodology. Passby noise predictions were made along the entire alignment of each of the rail alternatives.

In regions where special trackwork is included, such as at crossovers, the wheel impact at the frogs, switch points or other discontinuities can significantly increase the radiated noise levels. As such, a correction factor of +6 dBA must be added to the wayside noise levels in order to account for the added

wheel/rail noise at the discontinuities at special trackwork sections. The wheel impacts occur with every train passby regardless of train direction or switch position. Our analysis which is indicated "near x-over" assumes that a standard switch will be used at the crossover.

As previously indicated, wayside noise data used in this analysis are based on measured data for BART and design data for the Guadalupe Corridor LRT system and are applicable to both at-grade and aerial operations in open terrain. If there are rows of buildings along the alignment, the sound levels at large distances from the track may be somewhat less than would be expected for open, level terrain because of the shadowing effect created by the buildings. This shadowing effect is only present when the sound waves from the transit train are directly shadowed by intervening buildings and only the first row of buildings provides any significant noise reduction. The subsequent rows of buildings or homes do not create any significant additional or additive noise reduction beyond that created by the first row of shadowing buildings. At those locations along an aerial structure where the first row of buildings is of two stories or more in height, additional attenuation of the train noise will be provided behind these buildings for locations which are lower than the building closest to the transit alignment.

All of the noise generated by a transit car in operation originates in the area beneath the car. The main sources are noise radiated by vibration of the wheels and rails due to wheel/rail interaction and the noise radiated by the propulsion system. The auxiliary equipment and vibration of other undercar components also contribute to the noise, but aerodynamic noise and vibration of the upper parts of the car body do not contribute significantly to the wayside noise. Therefore, a sound barrier wall shielding or shadowing the noise from beneath the car is a very effective noise abatement technique.

One of the most important features of the barrier wall design is the height of the wall relative to the transit car wheels and side skirt. Another important feature is that the wall must have no holes or slots which would allow transmission of sound through the wall. For ballast and tie installations the sound barrier walls can be constructed in a variety of configurations. The basic requirement is the provision of a solid wall with sufficient height to shadow the noise transmitted from the transit trains to the wayside. No sound absorption is necessary on a ballast and tie track sound barrier wall for full effectiveness because of the sound absorption provided by the ballast.

6.3 Wayside Noise Level Comparison with Absolute Criteria

Tables 6-1 through 6-5 indicate a comparison of the expected wayside noise levels, from train passbys for each of the major rail alternatives, with the criteria presented in Chapter 5. The range of predicted noise levels indicates the amount of variability to be expected based on extensive measurements. Also indicated in these tables are the sub-alternatives (e.g., 4A, 7A) by their terminal points. These comparison of predicted noise vs. criterion indicate where sound barrier walls would be necessary to reduce the noise to an appropriate level and are based on the simple concept of passby noise for a single event. The data shown on this table provide information on the noise levels of an individual passby, but do not account for the duration of each passby or the number of events per hour or day. These factors are, however, accounted for when evaluating the noise exposure levels for the trains utilizing the energy equivalent noise level, L_{eq}, as previously discussed. Cumulative effects of numerous passbys are presented in Section 6.4.

The data presented in Tables 6-1 through 6-5 include the location along the alignment by civil station number and direction from the alignment, the type of building structure, the distance from the near track centerline to the nearest buildings under consideration, the maximum train speed for the area, the criteria for allowable levels, based on APTA Guidelines, and the expected maximum wayside noise levels with and without sound barrier wall for peak-hour train consist specified for each alternative (e.g., Alternative 4 is a 2-car train). The noise levels for the peak hour train consist are used since those levels will be the maximum experienced at wayside locations.

The civil stationing and crossover locations are based on Plan and Profile drawings dated 6 November 1987, as are distances from near track centerline to nearest buildings. The location of crossovers and train speeds are based on Trackwork Schematic Drawings received by Wilson, Ihrig & Associates, Inc. 16 May 1988, applying the nominal maximum acceleration and deceleration rates of 3.2 mph, with a maximum operating speed of 60 mph for LRV and 70 mph for BART trains except in areas with civil speed restrictions.

Although nearly so, Tables 6-1 through 6-5 are not all inclusive, in that they do not provide a noise projection to every building adjacent to the proposed alignment. However, they do provide a noise projection to the nearest buildings or to the nearest building of a group in which the occupants might experience some noise impact from the transit train operations. In addition, since the wayside noise projections are for the nearest buildings of a group, buildings within the group but further away from the alignment will experience lower wayside noise levels. Thus, at those locations where the tables indicate the need for a sound barrier wall to reduce the noise, the sound barrier wall will only be necessary to reduce the noise levels at locations which are

closer to the alignment than the "Required Distance for Criterion Compliance", which is indicated on the Tables. We have considered that there is substantial compliance with the criterion if the upper limit of the range of predicted maximum noise for particular peak hour train consist is within 2 dB of the appropriate criterion.

Review of Tables 6-1 through 6-5 indicates that there are several locations or areas where sound barrier walls could be used to reduce the wayside noise from train passbys to an acceptable and appropriate level. There are also locations where the Tables indicate the need for a sound barrier wall where we believe that a sound barrier wall may not be needed based on a more detailed analysis during engineering design.

At this time, the extent or length of sound barrier wall at each location where it is needed has not been indicated. The exact height, length and location of the sound barrier walls will be determined during preliminary and final design of the selected system and alignment. Tables 6-1 through 6-5 indicate that for most of those locations identified as needing a sound barrier wall, the use of a nominal height sound barrier wall alone should reduce the wayside passby noise level to be equal to or less than the criterion for allowable levels.

As indicated in the general discussion of wayside noise from aerial structure operation, situations arise where a sound barrier wall alone does not result in adequate noise reduction. A sound absorptive treatment applied to the inside face of the sound barrier wall will usually result in a further 3 dBA noise reduction. Where such treatment appears necessary, this is indicated in the following discussion. The results of wayside noise predictions for each of the various alternatives are discussed below.

Alternative 4 (LRT to Antioch via Highway 4)

From the predicted wayside noise levels in Table 6-1 for this alternative, it can be seen that, progressing in the out-bound direction, the first location on the aerial structure where a sound barrier wall on the out-bound side might be necessary is near station 16+00. There is a crossover centered at station 17+00. The commercial building at this location is within 25 ft of the near track alignment. With a standard switch, which has been indicated for this location, wayside noise levels are expected to exceed the criterion somewhat. Because the building is close to the aerial structure and additional shielding from the aerial structure may result in lower levels, and the criterion is only exceeded slightly, actual need for a sound barrier wall at this location can only be determined during engineering design. A special switch frog could also be used at this location to reduce the noise levels.

Between station 33+00 and 40+00 is Baldwin Park on the out-bound side. Projected noise levels here are expected to exceed the criterion somewhat at the closest point in the park. However, current ambient noise levels from traffic on Port Chicago Highway are also high. Further away from the highway where the ambient levels are more compatible with a park-like setting the LRT wayside noise levels will also be lower. Specific need for a sound barrier wall on the aerial structure for this location should be determined during engineering design. Mt. Diablo Hospital is far enough away from the aerial structure so as not to warrant a sound barrier wall on the in-bound side.

The first location where a sound barrier wall on the aerial structure is most likely needed starts at station 40+00 just after Baldwin Park. The residences on the eastern side of Port Chicago Highway are within 50 ft of the near track. Houses on the western

side are 75 to 100 ft away. A sound barrier wall on both sides of the aerial structure should result in acceptable levels of wayside noise due to individual train passbys.

However, it should be noted that the wayside noise criterion being used for these residences is that for a Category III Area (see Table 5-1). One would typically expect L_{dn} less than 65 dBA for this Category. Along Port Chicago Highway, ambient measurements performed for this study indicate that this ambient level already exists. Although not done for this analysis, it may be justified to relax slightly the 75 dBA passby criterion. Specific need for sound barrier walls in this area can be re-examined in the engineering phase. Furthermore, given projected traffic volumes for the year 2000 and planned widening of the highway, ambient noise levels should increase by 2 to 3 dBA.

Along the at-grade (between station 55+50 to 130+00) ballast and tie portion of this alignment adjacent to Port Chicago Highway wayside, noise levels on the western side of the highway are expected to be low enough so as not to warrant a sound barrier for this side of the way structure. A properly designed and constructed sound barrier on the out-bound side of the alignment should result in acceptable wayside levels for residences on the eastern side of the highway. If Concord constructs a sound barrier wall at the property line on both sides of the highway, the LRT noise levels should be acceptable, assuming that a wall at least 6 ft high is built.

The remainder of the alignment for this alternative is in the median of Highway 4. As can be seen in Table 6-1, only in segments where there are crossovers or the alignment is close enough, are the noise levels expected to be high enough to warrant a sound barrier wall along the alignment on Highway 4. The crossover centered at station 395+00 would result in high noise

levels, at nearby residences and an elementary school, that can be reduced using either a sound barrier wall on both the in-bound and out-bound sides or a special switch frog.

Near the end of this alignment alternative, between stations 836+00 and 841+00, on the in-bound side, there are several commercial buildings and two residences that are close to the aerial structure. A sound barrier wall would sufficiently reduce the wayside levels in this location. Alternative 4A alignment terminates at the West Antioch Station and would therefore not affect these buildings.

Alternative 5 (LRT to Antioch via Highway 4 and SPRR)

This alignment follows the same route as Alternative 4 until reaching Willow Pass Road at its intersection with Highway 4. The operational specifications for the LRT system are also the same up to this point. Consequently, the same requirements for sound barrier walls that apply to Alternative 4 up to station 310+00 also apply to this alternative. Wayside noise levels for Alternative 5 are shown in Table 6-2.

The commercial buildings and residences along the Willow Pass Road segment of the alignment is subjected to a relatively high existing noise environment due to automobile and heavy truck traffic on Willow Pass Road. As a result of the high ambient noise in this area, the residential community fronting the road would not be impacted by LRT wayside noise, except for a group of houses, between stations 352+00 and 360+00, currently being built near the proposed West Pittsburg Station.

A sound barrier wall has been constructed for the residential project, along the Willow Pass Road property line, reducing the impact of traffic noise. The ambient noise level behind the existing sound barrier wall is estimated to be low enough to place

the residences in Category III (see Table 5-1). The proposed aerial structure for this part of the alignment would raise the LRT system above the wall, thereby eliminating any possible shielding the newly constructed wall would otherwise provide for at-grade or street level noise sources. A standard (nominal) sound barrier wall would be needed on the in-bound side of the structure.

Beyond station 395+00, the alignment for this alternative would be within the SPT right-of-way until near the East Antioch Station. The ambient noise levels along this portion of the alignment are currently much lower than they probably have been in the past given the current level of freight traffic. As already noted, this could change significantly depending on the outcome of a buyout of the SPT by another rail line.

For the current levels of ambient noise, the residences along the SPT right-of-way are in a Category III Area (see Table 5-1). Where the near track alignment is 100 ft or more from the nearest single-family residences along this part of the alignment, wayside noise levels for transit train operation on standard trackwork are expected to be low enough without a sound barrier wall.

Between station 586+00 and 619+00, there are single-family residences within 75 ft of the near track on both the in-bound and out-bound sides. There is also a crossover centered at station 592+00 that would result in high wayside noise levels unless special switch frogs were used. However, even with a special switch frog, the houses are still close enough to warrant a sound barrier wall along this section. Installation of a properly designed and constructed sound barrier wall would reduce wayside noise to acceptable levels even if standard switch frogs were used.

Between station 770+00 and 792+00, and station 815+00 and 835+00, there are residences within 50 ft of the near track of this alignment. For this close distance, wayside noise levels for individual train passbys are significantly above the criterion. A sound barrier wall should reduce transit train noise at these residences to acceptable levels.

<u>Alternative 6 (BART to North Concord/Martinez)</u>

Table 6-3 indicates the wayside noise levels expected for this alternative. Due to greater speeds and longer trains, the predicted wayside noise levels are much higher than for the LRT alternative alignments, as can be seen by comparing Table 6-3 with 6-1.

Predicted wayside noise levels at the commercial building between station 8+50 and 10+00 are high enough to warrant a sound barrier wall on the out-bound side of the aerial structure. Between station 11+00 and 23+50 there are offices, commercial buildings, residences, a church and a school which would be impacted by wayside noise levels unless a sound barrier wall were installed on the out-bound side of the way structure. As can be seen, a sound barrier wall would reduce noise to acceptable levels.

A sound barrier wall on both sides of the aerial structure between station 20+50 and 40+00 would result in acceptable wayside noise levels for the offices, residences, hospital and park in this area.

Between station 40+00 and 55+50, there are single-family residence which would be within 50 ft of the near track of the aerial structure. As indicated in Table 6-3, additional noise reduction beyond that provided by a sound barrier wall would be needed.

With the addition of sound absorptive material on the out-bound side sound barrier wall, wayside noise levels should be acceptable except for three to five residences between station 54+00 and 55+50.

Even with a sound barrier wall, sound absorption treatment and a possible relaxation of the criterion to account for existing ambient noise being high for the Area Category corresponding to that criterion (see Table 5-1), the wayside noise levels are expected to be 77 to 79 dBA for individual train passbys at these three residences. Additional noise reduction for this location could also be achieved by a reduction in train speed. If this is not practical, then these houses would be exposed to an unavoidable noise impact.

Adjacent to the at-grade sections of the alignment along Port Chicago Highway, there are approximately 55 houses that are 25 ft from the near track on the out-bound side. At this close distance the typical height sound barrier wall for at-grade facilities would not result in acceptable wayside noise levels as indicated in Table 6-3. The addition of absorptive treatment to a wall of this height is not expected to produce the needed reduction in noise. With a higher wall (greater than 5 ft) and absorption, it may be possible to achieve noise levels that are acceptable. The feasibility of a higher wall can be studied in the engineering phase.

The residences on the west side of Port Chicago Highway would be exposed to wayside noise that should be within the criterion if a nominal height wall were installed at the edge of the way structure along the at-grade alignment. The depressed and cut-and-cover sections of this alignment along the highway should provide adequate shielding to result in acceptable noise levels for houses on both sides of this part of the alignment.

The crossover centered at station 100+00 will result in exceptionally high levels of wayside noise for those houses adjacent to the switch frogs if standard frogs are used. An 18 dBA reduction in noise levels would be necessary to satisfy the wayside noise criterion for houses at 25 ft from the out-bound track, unless special switch frogs were used. It is not practical to achieve this much reduction with a reasonable height noise barrier. Even with a higher wall (8 to 10 ft above top-of-rail) and absorptive treatment, wayside noise levels for individual trains would probably be in excess of 80 dBA. There are approximately 20 houses in this area which would be affected. The use of special switch frogs might reduce the noise levels to satisfy APTA guidelines.

Houses on the east side of Port Chicago Highway between approximately stations 113+00 to 130+00 are elevated above the highway level, but have an existing sound barrier wall that will provide shielding from wayside noise. It may be possible during engineering design to reduce the length of sound barrier wall needed between these stations.

Alternative 7 (BART to Antioch via Highway 4

This alternative has the same alignment as Alternative 6 up to the North Concord/Martinez Station. Beyond this point the alignment is within the median of Highway 4 until near the East Antioch Station, which would be on the north side of Highway 4.

Aside from the difference in length, the main difference between Alternatives 6 and 7 are the shorter train consists of Alternative 7. The trains in Alternative 7 are half as long. This will result in emitted noise levels that are about 2 to 3 dBA less for Alternative 7 compared to Alternative 6.

Wayside noise levels will be reduced accordingly and demands on sound barrier wall design will be reduced. Table 6-4 indicates wayside noise levels that should be acceptable along Port Chicago Highway with use of sound barrier walls where indicated. The only area where a nominal sound barrier wall will not result in adequate reduction is adjacent to the crossover switch frogs. A special switch frog is needed to produce acceptable levels.

It may be possible during engineering design to perform more detailed analysis which could eliminate some of the need for sound barrier wall on the out-bound side between stations 11+00 and 21+50 if shielding from intervening buildings could achieve the necessary noise reduction.

Except for the residences on the east side of Port Chicago Highway between stations 40+00 and 55+00, the predicted wayside noise levels would be acceptable with installation of a sound barrier wall on both sides of the aerial structure. Absorptive treatment may be needed for the sound barrier wall on the out-bound side to produce satisfactory noise levels for the seven or eight residences on the east side of the highway.

As indicated in Table 6-4, the wayside noise levels at most of the residences on the east side of Port Chicago Highway adjacent to the at-grade sections of the alignments would only be slightly above (3 dBA) the criterion if a typical height (5 ft above top-of-rail) sound barrier were installed. A somewhat higher wall on the out-bound side of the way structure and possible absorptive treatment would probably result in acceptable noise levels for the potentially affected residences. Details of the actual wall design can be determined in the engineering phase.

Use of a standard switch frog for the crossover centered at station 100+00 would result in unacceptable noise levels for about twenty residences on the out-bound side of the alignment in this area. Even with the installation of a higher than typical sound

barrier including absorptive treatment, the wayside noise levels would still exceed 80 dBA for several of the residences. Use of a special switch frog for the crossover and installation of a properly designed and constructed sound barrier wall should result in acceptable wayside noise levels for this area.

The remainder of this alternative alignment is within the median of Highway 4 until near the East Antioch Station where it crosses over the freeway to the north side. Due primarily to the existing high ambient noise levels along this portion of the alignment and also the somewhat greater distances between the near track and potentially affected buildings, there are only a few locations where sound barrier walls would be needed to reduce wayside noise levels.

The crossover centered at station 395+00 will result in noise levels which exceed the APTA guidelines at several residences, a school and a park if standard switch frogs are used. Installation of a sound barrier wall would still result in unacceptable noise levels. Use of special switch frogs would result in wayside noise levels that might satisfy the APTA guidelines except for possibly the Bel Air Elementary School where wayside levels would still be exceeded slightly. Further measurement of existing ambient noise at the school and identification of the closest buildings or areas used for school activities should be done in the engineering design phase to determine whether a sound barrier wall would be needed for this location. Alternative 7A terminates just beyond the West Pittsburg Station and would probably not affect this area depending on location and crossovers here and train speeds at the end of that alignment.

The other areas that would be affected by wayside noise along the Highway 4 alignment are those adjacent to aerial structure and crossovers. There are about 155 residences between station 431+00 to 478+00, on both the in-bound and out-bound sides that are 100 to 150 ft from the respective near track. Use of a sound barrier

wall on the aerial structure would produce acceptable levels of wayside noise for these residences. The crossover centered at station 547+00 would result in unacceptable noise levels at several residences and commercial buildings in this area unless a sound barrier wall was installed. If special switch frogs are used for the crossover, then a sound barrier wall would not be necessary here.

Alternative 7B terminates just beyond the Pittsburg Station. The following discussion only applies to Alternative 7.

The crossover centered at station 685+00 would produce unacceptable noise levels at the nearby Kaiser Medical Center, unless special switch frogs are installed. If standard switch frogs are used then a sound barrier wall on the way structure would provide the necessary noise reduction.

About one-half mile before the East Antioch Station the alignment is on aerial structure. From station 819+00 to 831+00 there are four churches on the out-bound side of the alignment. With a standard sound barrier wall the noise levels would be within the criteria for these buildings. There are also three commercial buildings and two residences close to the aerial structure on the in-bound side of the alignment after it has left the median of Highway 4. A sound barrier wall in this location would result in acceptable levels of wayside noise.

<u>Alternative 8 (BART to North Concord/Martinez and LRT to West Antioch via Highway 4</u>

This alternative is a combination of BART up to the proposed North Concord/Martinez Station and LRT thereafter to West Antioch via the median of Highway 4. The operational parameters are those of

Alternative 7 for BART and Alternative 4 for LRT. The requirements for sound barrier walls and resulting noise impact on the adjacent community are discussed above under the respective Alternatives. The predicted wayside noise levels are presented in Table 6-5.

6.4 Noise Exposure Levels and Comparisons with Relative Criteria

As previously discussed, the single-event passby noise does not account for the cumulative effect of noise since the noise level from an individual passby does not account for the duration of each passby or the number of events per hour or day. This is because a loud noise occurring very seldom may be less annoying or intrusive than a moderate noise occurring many times.

The long-term noise exposure due to transit train operations in combination with ambient noise has been determined for selected noise sensitive areas for each Alternative Alignment. The results are presented in Tables 6-6 through 6-9 in terms of the day/night average level (L_{dn}) for the year 2000. This measure allows an assessment of the expected long term noise exposure that individuals living or working near the transit route will experience for an entire day. The estimate of noise exposure due only to train operations is based on the passby sound levels, the duration of the sound and the number of passbys per hour. The number of passbys per hour and train length are based on a preliminary operating schedule for a weekday. The noise exposure levels for weekends and holidays will be less. The existing ambient for each location is based on ambient noise data obtained for this study and estimated increases in ambient noise levels given projected increases in traffic within the Corridor area.

A secondary impact of all the rail alternatives would be due to relocation of Port chicago Highway median from its current location. The median would need to be relocated to about 5 ft to the east of the existing median.

Local plans also anticipate widening the highway to 4 lanes to accommodate the increase in local traffic as discussed under Alternative 1 (No Build). Relocation would have a beneficial effect when compared to the existing location of the highway, but without a rail structure in this area the highway median could be located in the center of the corridor, which would move the traffic noise source further away from the houses on the west side. The net result of relocating the highway is expected to be a 1 to 2 dBA increase in traffic noise on the west side of the highway and a corresponding decrease on the east side of the highway. These effects have been accounted for in the projected ambient levels for the year 2000.

As indicated in the discussion of the No Build Alternative in Chapter 9, the City of Concord will probably need to deal with the increased noise levels along Port Chicago Highway in the near future. Their approach to solving the problem would have an effect on the noise im pact from the at-grade sections of the rail alternatives along this part of the alignment.

The locations presented in Tables 6-6 through 6-9 are all areas adjacent to the alignments where sound barrier walls were needed for eduction of wayside noise based on individual train passby guidelines. Also presented in these Tables are data on the predicted peak hour L_{eq} (peak) for each of the locations examined. The L_{eq} (peak) accounts for the effects of several train passbys during times when train activity is greatest. This measure allows for assessment of expected noise exposure over a longer term than an individual train passby. Data presented account for the combined noise due to both train operation and projected future ambient levels for each location.

The data presented in Tables 6-6 through 6-9 for L_{dn} and L_{eq} (peak) can be compared with the UMTA criteria for impact assessment as presented in Chapter 5. To assess impact, the change in levels from existing conditions (1988) to projected conditions are examined. An increase of 0 to 3 dBA is considered "generally not significant", whereas an increase of 6 dBA or more is considered "generally significant". An increase in noise exposure level of 4 to 5 dBA is considered "possibly significant".

From Table 6-6 for Alternative 4, it can be seen that where a sound barrier wall is used, the increase in noise exposure levels are 2 dBA or less. The noise impact for this alternative would not be significant if sound barrier walls were used where indicated for satisfaction of passby noise criteria.

The conclusions, based on data in Table 6-7, are similar for Alternative 5, except for the area with residences along the SPT right-of-way which are within 50 ft of the transit alignment. A 4 dBA increase is indicated for the peak hour L_{eq}. A possible impact may exist for these residences even with use of a standard sound barrier wall. A slightly higher (greater than 5 ft) barrier wall and absorptive treatment should eliminate this possible impact, if necessary.

A secondary impact of the SPTC alignment is the effect of moving the existing freight line tracks approximately 12 to 15 ft to the north of the exiting track location. This will have the effect of slightly reducing freight train noise in the residential community to the south of the tracks and the opposite effect on the community on the other side.

As indicated in Section 6.3 in the analysis of passby noise levels, sound absorptive treatment may be needed on sections of the aerial structure for Alternative 6. From the data in Table 6-8, it can be seen that an additional 3 dBA reduction would be

needed for no significant impact for the area where residences are within 50 ft of the alignment. The residences further away would also experience a 6 dBA increase without this absorptive treatment.

As can be seen in Table 6-9, the expected increase in L_{dn} and L_{eq} (peak) are somewhat less for Alternative 7 compared with Alternative 6. However, the requirements for sound barrier wall and absorptive treatment are similar based on the data.

TABLE 6-1 AIRBORNE NOISE PROJECTIONS FOR BART ALTERNATIVE 4 (LRT TO ANTIOCH VIA HIGHWAY 4)

					No Sound Barrier Wall		Sound Barrier Wall	
Station Number and Direction from Alignment	Type of Structure (N)*	Distance Near Track to Nearest Building (ft)	Maximum Train Speed (mph)	Criterion for Allowable Levels (dBA)	Predicted Maximum Noise 2-car Train (dBA)	Required Distance for Criterion Compliance (ft)	Predicted Maximum Noise 2-car Train (dBA)	Required Distance for Criterion Compliance (ft)
Aerial Structure:								
8+50 to 10+00 (IB)	Commercial (1)	25	35	85	77-80	--	--	--
9+00 to 15+00 (OB)	Mixed Commercial/ Residential (7)	200	35	80	68-71	--	--	--
10+00 to 14+00 (IB)	Commercial (3)	200	35	85	68-71	--	--	--
11+00 to 13+50 (OB)	Commercial (7)	75	35	85	75-78	--	--	--
15+00 to 17+50 (OB)	Commercial (1)	25	35 @ x-over	85	85-88	75	78-81	--
17+00 to 18+50 (IB)	Commercial (1)	200	35 @ x-over	85	74-77	--	--	--
20+00 to 21+50 (OB)	Commercial (1)	150	35	85	70-73	--	--	--
20+50 to 23+00 (IB)	Mixed Commercial/ Apartments (6)	25	35	80	77-82	--	--	--
22+00 to 23+50 (OB)	Mixed Residential/ Offices (4)	50	35	80	77-80	--	--	--

TABLE 6-1 (CONTINUED)

Station Number and Direction from Alignment		Type of Structure (N)*	Distance Near Track to Nearest Building (ft)	Maximum Train Speed (mph)	Criterion for Allowable Levels (dBA)	No Sound Barrier Wall: Predicted Maximum Noise 2-car Train (dBA)	No Sound Barrier Wall: Required Distance for Criterion Compliance (ft)	Sound Barrier Wall: Predicted Maximum Noise 2-car Train (dBA)	Sound Barrier Wall: Required Distance for Criterion Compliance (ft)
24+00 to 33+00	(OB)	Residential (13)	100	35	75	73-76	--	--	--
24+00 to 34+00	(IB)	Medical Office/ Residential (10)	50	35	80	77-80	--	--	--
33+00 to 40+00	(OB)	John F. Baldwin Park	75	35	75	75-78	250	68-71	--
38+50 to 46+00	(IB)	Mt. Diablo Hospital	300	35	75	64-67	--	--	--
40+00 to 51+00	(OB)	Residential (16)	50	35	75	77-80	125	70-73	--
47+50 to 51+00	(IB)	Residential (7)	75	35	75	75-78	125	68-71	--
51+00 to 54+00	(OB)	Residential (5)	35	35	75	78-81	125	70-73	--
51+00 to 54+00	(OB)	Residential (6)	90	35	75	74-77	--	--	--
54+00 to 55+50	(OB)	Residential (3)	25	35	75	79-82	125	72-75	--

TABLE 6-1 (CONTINUED)

Station Number and Direction from Alignment	Type of Structure (N)*	Distance Near Track to Nearest Building (ft)	Maximum Train Speed (mph)	Criterion for Allowable Levels (dBA)	No Sound Barrier Wall: Predicted Maximum Noise 2-car Train (dBA)	No Sound Barrier Wall: Required Distance for Criterion Compliance (ft)	Sound Barrier Wall: Predicted Maximum Noise 2-car Train (dBA)	Sound Barrier Wall: Required Distance for Criterion Compliance (ft)
54+00 to 55+50 (IB)	Residential (3)	100	35	75	73-76	--	--	--
At-Grade:								
55+50 to 84+00 (OB)	Residential (35)	25	35	75	76-79	75	69-72	--
55+50 to 77+00 (IB)	Residential (28)	100	35	75	69-72	--	--	--
77+00 to 86+50 (IB)	Commercial (12)	100	35	85	69-72	--	--	--
84+00 to 114+00 (OB)	Residential (44)	25	45	75	78-81	100	71-74	--
86+50 to 114+00 (IB)	Residential (50)	100	45	75	71-74	--	--	--
106+20 to 107+00 (IB)	Preschool	125	45	75	70-73	--	--	--
110+80 to 111+80 (IB)	Church	100	45	75	71-74	--	--	--
114+00 to 130+00 (IB)	Residential (12)	150	50	75	69-72	--	--	--

TABLE 6-1 (CONTINUED)

Station Number and Direction from Alignment	Type of Structure (N)*	Distance Near Track to Nearest Building (ft)	Maximum Train Speed (mph)	Criterion for Allowable Levels (dBA)	No Sound Barrier Wall: Predicted Maximum Noise 2-car Train (dBA)	No Sound Barrier Wall: Required Distance for Criterion Compliance (ft)	Sound Barrier Wall: Predicted Maximum Noise 2-car Train (dBA)	Sound Barrier Wall: Required Distance for Criterion Compliance (ft)
307+00 to 367+00 (IB)	Residential (63)	325	60	80	64-67	--	--	--
380+00 to 386+00 (IB/OB)	Residential (6)	250	60 @ x-over	80	73-76	--	--	--
390+00 to 393+00 (OB)	Residential (4)	125	60 @ x-over	80	79-82	200	71-74	--
391+00 to 397+00 (IB)	Bel Air Elementary School	200	60 @ x-over	75	75-78	300	67-70	--
396+00 to 420+00 (OB)	Ambrose Park	150	60 @ x-over	80	77-80	--	--	--
399+00 to 403+00 (IB)	Residential (7)	150	60	80	77-80	--	--	--
Aerial Structure:								
432+00 to 478+00 (IB)	Residential (100)	150	60	80	76-79	--	--	--
438+00 to 478+00 (OB)	Residential (55)	100	60	80	79-82	--	--	--
At Grade:								
489+00 to 498+00 (IB)	Apartments (17)	125	60	85	73-76	--	--	--

TABLE 6-1 (CONTINUED)

Station Number and Direction from Alignment		Type of Structure (N)*	Distance Near Track to Nearest Building (ft)	Maximum Train Speed (mph)	Criterion for Allowable Levels (dBA)	No Sound Barrier Wall: Predicted Maximum Noise 2-car Train (dBA)	No Sound Barrier Wall: Required Distance for Criterion Compliance (ft)	Sound Barrier Wall: Predicted Maximum Noise 2-car Train (dBA)	Sound Barrier Wall: Required Distance for Criterion Compliance (ft)
506+00 to 524+00	(IB/OB)	Residential (46)	125	60	80	73-76	--	--	--
545+00 to 549+00	(IB)	Residential (9)	150	60 @ x-over	80	77-80	--	--	--
554+00 to 591+00	(IB)	Residential (12)	125	60	80	73-76	--	--	--
656+00 to 672+00	(OB)	Residential (23)	100	50	80	72-75	--	--	--
End of Alternative 4A (West Antioch Station)									
678+00 to 688+00	(OB)	Kaiser Medical Center	150	60	80	71-74	--	--	--
704+00 to 754+00	(IB/OB)	Apartments (52)	100	60	85	74-77	--	--	--
721+00 to 736+00	(OB)	Residential (27)	125	60	80	73-76	--	--	--
761+00 to 811+00	(OB)	Mixed Commercial/ Apartments (50)	125	60	85	73-76	--	--	--

TABLE 6-1 (CONTINUED)

Station Number and Direction from Alignment		Type of Structure (N)*	Distance Near Track to Nearest Building (ft)	Maximum Train Speed (mph)	Criterion for Allowable Levels (dBA)	No Sound Barrier Wall: Predicted Maximum Noise 2-car Train (dBA)	No Sound Barrier Wall: Required Distance for Criterion Compliance (ft)	Sound Barrier Wall: Predicted Maximum Noise 2-car Train (dBA)	Sound Barrier Wall: Required Distance for Criterion Compliance (ft)
Aerial Structure:									
820+00 to 832+00	(OB)	Churches (4)	150	60	80	71-74	--	--	--
836+00 to 838+00	IB)	Commercial (3)	25	60	85	85-88	75	76-79	--
838+00 to 841+00	(IB)	Residential (2)	75	60	80	81-84	150	72-75	--

(OB) = Outbound
(IB) = Inbound
*(N) = Number of Buildings ± 10%

TABLE 6-2 AIRBORNE NOISE PROJECTIONS FOR BART ALTERNATIVE 5 (LRT TO ANTIOCH VIA HIGHWAY 4 AND SPRR)

Station Number and Direction from Alignment		Type of Structure (N)*	Distance Near Track to Nearest Building (ft)	Maximum Train Speed (mph)	Criterion for Allowable Levels (dBA)	No Sound Barrier Wall		Sound Barrier Wall	
						Predicted Maximum Noise 2-car Train (dBA)	Required Distance for Criterion Compliance (ft)	Predicted Maximum Noise 2-car Train (dBA)	Required Distance for Criterion Compliance (ft)
Aerial Structure:									
8+50 to 10+00	(IB)	Commercial (1)	25	35	85	77-80	--	--	--
9+00 to 15+00	(OB)	Mixed Commercial/ Residential (7)	200	35	80	68-71	--	--	--
10+00 to 14+00	(IB)	Commercial (3)	200	35	85	68-71	--	--	--
11+00 to 13+50	(OB)	Commercial (7)	75	35	85	75-78	--	--	--
15+00 to 17+50	(OB)	Commercial (1)	25	35 @ x-over	85	85-88	75	78-81	--
17+00 to 18+50	(IB)	Commercial (1)	200	35 @ x-over	85	74-77	--	--	--
20+00 to 21+50	(OB)	Commercial (1)	150	35	85	70-73	--	--	--
20+50 to 23+00	(IB)	Mixed Commercial/ Apartments (6)	25	35	80	79-82	--	--	--
22+00 to 23+50	(OB)	Mixed Residential/ Apartments (4)	50	35	80	77-80	--	--	--

TABLE 6-2 (CONTINUED)

Station Number and Direction from Alignment		Type of Structure (N)*	Distance Near Track to Nearest Building (ft)	Maximum Train Speed (mph)	Criterion for Allowable Levels (dBA)	No Sound Barrier Wall: Predicted Maximum Noise 2-car Train (dBA)	No Sound Barrier Wall: Required Distance for Criterion Compliance (ft)	Sound Barrier Wall: Predicted Maximum Noise 2-car Train (dBA)	Sound Barrier Wall: Required Distance for Criterion Compliance (ft)
24+00 to 33+00	(OB)	Residential (13)	100	35	75	73-76	--	--	--
24+00 to 34+00	(IB)	Medical Office/ Residential (10)	50	35	85	77-80	--	--	--
33+00 to 40+00	(OB)	John F. Baldwin Park	75	35	75	75-78	250	68-71	--
38+50 to 46+00	(IB)	Mt. Diablo Hospital	300	35	75	64-67	--	--	--
40+00 to 51+00	(OB)	Residential (16)	50	35	75	77-80	125	70-73	--
47+50 to 51+00	(IB)	Residential (7)	75	35	75	75-78	125	68-71	--
51+00 to 54+00	(OB)	Residential (5)	35	35	75	78-81	125	71-74	--
51+00 to 54+00	(OB)	Residential (6)	90	35	75	74-77	--	--	--
54+00 to 55+50	(OB)	Residential (3)	25	35	75	79-82	125	72-75	--
54+00 to 55+50	(IB)	Residential (3)	100	35	75	73-76	--	--	--

TABLE 6-2 (CONTINUED)

Station Number and Direction from Alignment		Type of Structure (N)*	Distance Near Track to Nearest Building (ft)	Maximum Train Speed (mph)	Criterion for Allowable Levels (dBA)	No Sound Barrier Wall: Predicted Maximum Noise 2-car Train (dBA)	No Sound Barrier Wall: Required Distance for Criterion Compliance (ft)	Sound Barrier Wall: Predicted Maximum Noise 2-car Train (dBA)	Sound Barrier Wall: Required Distance for Criterion Compliance (ft)
At-Grade:									
55+50 to 84+00	(OB)	Residential (35)	25	35	75	76-79	75	69-72	--
55+50 to 77+00	(IB)	Residential (28)	100	35	75	69-72	--	--	--
77+00 to 86+50	(IB)	Commercial (12)	100	35	85	69-72	--	--	--
84+00 to 114+00	(OB)	Residential (44)	25	45	75	78-81	100	71-74	--
86+50 to 114+00	(IB)	Residential (50)	100	45	75	71-74	--	--	--
106+20 to 107+00	(IB)	Preschool	125	45	75	70-73	--	--	--
110+80 to 111+80	(IB)	Church	100	45	75	71-74	--	--	--
114+00 to 130+00	(IB)	Residential (12)	150	50	75	69-72	--	--	--

TABLE 6-2 (CONTINUED)

Station Number and Direction from Alignment		Type of Structure (N)*	Distance Near Track to Nearest Building (ft)	Maximum Train Speed (mph)	Criterion for Allowable Levels (dBA)	No Sound Barrier Wall: Predicted Maximum Noise 2-car Train (dBA)	No Sound Barrier Wall: Required Distance for Criterion Compliance (ft)	Sound Barrier Wall: Predicted Maximum Noise 2-car Train (dBA)	Sound Barrier Wall: Required Distance for Criterion Compliance (ft)
Aerial Structure:									
320+00 to 327+00	(OB)	Mobile Homes (13)	175	45	85	72-75	--	--	--
330+00 to 333+00	(IB)	Church (1)	200	45	75	71-74	--	--	--
332+00 to 337+00	(OB)	Residential (6)	125	45	80	75-78	--	--	--
338+00 to 350+00	(IB)	Apartments (7)	100	45	85	76-79	--	--	--
342+00 to 363+00	(OB)	Mixed Commercial/ Residential (19)	50	45	85	80-83	--	--	--
352+00 to 360+00	(IB)	Residential (14)	75	45	75**	78-81	175	71-74	--
At Grade:									
455+00 to 474+00	(OB)	Commercial (10)	75	60	85	76-79	--	--	--
480+00 to 486+00	(OB)	Residential (9)	100	60	80	74-77	--	--	--

TABLE 6-2 (CONTINUED)

Station Number and Direction from Alignment		Type of Structure (N)*	Distance Near Track to Nearest Building (ft)	Maximum Train Speed (mph)	Criterion for Allowable Levels (dBA)	No Sound Barrier Wall: Predicted Maximum Noise 2-car Train (dBA)	No Sound Barrier Wall: Required Distance for Criterion Compliance (ft)	Sound Barrier Wall: Predicted Maximum Noise 2-car Train (dBA)	Sound Barrier Wall: Required Distance for Criterion Compliance (ft)
534+00 to 553+00	(OB)	Residential (14)	100	60	75	74-77	--	--	--
553+00 to 564+00	(OB)	Park	100	60	75	74-77	--	--	--
570+00 to 578+00	(OB)	Residential (25)	100	50	75	74-77	--	--	--
578+00 to 585+00	(OB)	Pittsburg High School	250	50	75	65-68	--	--	--
586+00 to 589+00	(OB)	Residential (10)	75	60	75	76-79	150	68-71	--
589+00 to 595+00	(IB/OB)	Residential (18)	75	60 @ x-over	75	82-85	250	74-77	--
595+00 to 619+00	(OB)	Residential (58)	75	60	75	76-79	150	68-71	--
624+00 to 690+00	(IB/OB)	Commercial (15)	75	60	85	76-79	--	--	--
730+00 to 735+00	(IB/OB)	Commercial (9)	50	60	85	78-81	--	--	--

TABLE 6-2 (CONTINUED)

Station Number and Direction from Alignment		Type of Structure (N)*	Distance Near Track to Nearest Building (ft)	Maximum Train Speed (mph)	Criterion for Allowable Levels (dBA)	No Sound Barrier Wall: Predicted Maximum Noise 2-car Train (dBA)	No Sound Barrier Wall: Required Distance for Criterion Compliance (ft)	Sound Barrier Wall: Predicted Maximum Noise 2-car Train (dBA)	Sound Barrier Wall: Required Distance for Criterion Compliance (ft)
738+00 to 770+00	(IB/OB)	Mixed Residential/ Apartments (74)	75	60	80	76-81	--	--	--
770+00 to 792+00	(OB)	Residential (36)	50	60	75	76-81	125	70-73	--
Aerial Structure:									
792+00 to 815+00	(IB/OB)	Mixed Commercial/ Residential/Apts. (54)	75	50	80	79-82	--	--	--
At-Grade:									
815+00 to 847+00	(IB)	Residential (55)	100	60	75	74-77	--	--	--
815+00 to 835+00	(OB)	Residential (46)	50	60	75	76-81	125	70-73	--
770+00 to 782+00	(IB)	Antioch High School	400	60	75	64-66	--	--	--
847+00 to 853+00	(IB)	Bidwell School	250	60	75	67-70	--	--	--
838+00 to 865+00	(OB)	Commercial (12)	50	60	85	78-81	--	--	--

(OB) = Outbound
(IB) = Inbound
*(N) = Number of Buildings ± 10%
** = See Text

TABLE 6-3 (CONTINUED)

Station Number and Direction from Alignment	Type of Structure (N)*	Distance Near Track to Nearest Building (ft)	Maximum Train Speed (mph)	Criterion for Allowable Levels (dBA)	No Sound Barrier Wall: Predicted Maximum Noise 10-car Train (dBA)	No Sound Barrier Wall: Required Distance for Criterion Compliance (ft)	Sound Barrier Wall: Predicted Maximum Noise 10-car Train (dBA)	Sound Barrier Wall: Required Distance for Criterion Compliance (ft)
51+00 to 54+00 (IB)	Residential (6)	90	50	75	83-85	500	75-77	--
54+00 to 55+50 (OB)	Residential (3)	25	50	75	88-90	500	80-82**	150
54+00 to 55+50 (IB)	Residential (3)	100	50	75	79-81	500	75-77	--
At-Grade:								
55+50 to 58+00 (OB)	Residential (4)	25	50	75	85-87	300	78-80**	150
55+50 to 58+00 (IB)	Residential (4)	100	50	75	79-81	300	72-74	--
Depressed and Cut and Cover Section:								
58+00 to 68+00 (IB/OB)	Residential (27)	25	50	75	73-77	--	--	--
At Grade:								
68+00 to 79+00 (OB)	Residential (15)	25	50	75	85-87	300	78-80**	150
68+00 to 79+00 (IB)	Residential (11)	100	50	75	79-81	300	72-74	--

TABLE 6-3 (CONTINUED)

Station Number and Direction from Alignment		Type of Structure (N)*	Distance Near Track to Nearest Building (ft)	Maximum Train Speed (mph)	Criterion for Allowable Levels (dBA)	No Sound Barrier Wall: Predicted Maximum Noise 10-car Train (dBA)	No Sound Barrier Wall: Required Distance for Criterion Compliance (ft)	Sound Barrier Wall: Predicted Maximum Noise 10-car Train (dBA)	Sound Barrier Wall: Required Distance for Criterion Compliance (ft)
Depressed and Cut and Cover Section:									
79+00 to 91+50	(IB/OB)	Residential (26)	25	50	75	73-75	--	--	--
At Grade:									
91+50 to 95+00	(OB)	Residential (6)	25	50	75	85-87	300	78-80**	150
91+50 to 95+00	(IB)	Residential (6)	100	50	75	79-81	300	72-74	--
106+20 to 107+00	(IB)	Preschool	125	50	75	78-80	300	71-73	--
95+00 to 107+00	(OB)	Residential (20)	25	50 @ x-over	75	91-93	600	84-86**	250
108+50 to 120+50	(IB)	Residential (15)	100	50 @ x-over	75	85-87	600	78-80**	250
105+00 to 120+50	(IB)	Residential (21)	100	50	75	79-81	300	72-74	--
107+00 to 116+00	(OB)	Residential (9)	20	50	75	87-89	300	80-82**	150

TABLE 6-3 (CONTINUED)

Station Number and Direction from Alignment		Type of Structure (N)*	Distance Near Track to Nearest Building (ft)	Maximum Train Speed (mph)	Criterion for Allowable Levels (dBA)	No Sound Barrier Wall		Sound Barrier Wall	
						Predicted Maximum Noise 10-car Train (dBA)	Required Distance for Criterion Compliance (ft)	Predicted Maximum Noise 10-car Train (dBA)	Required Distance for Criterion Compliance (ft)
106+20 to 107+00	(IB)	Preschool	125	50	75	78-80	300	71-73	--
110+80 to 111+80	(IB)	Church	100	50	75	79-81	300	72-74	--
120+50 to 129+00	(IB)	Residential (17)	150	50	75	77-79	300	70-72	--

(OB) = Outbound
(IB) = Inbound
*(N) = Number of Buildings ± 10%
** = See Text

TABLE 6-4 AIRBORNE NOISE PROJECTIONS FOR BART ALTERNATIVE 7 (BART TO ANTIOCH VIA HIGHWAY 4)

Station Number and Direction from Alignment	Type of Structure (N)*	Distance Near Track to Nearest Building (ft)	Maximum Train Speed (mph)	Criterion for Allowable Levels (dBA)	No Sound Barrier Wall: Predicted Maximum Noise 5-car Train (dBA)	No Sound Barrier Wall: Required Distance for Criterion Compliance (ft)	Sound Barrier Wall: Predicted Maximum Noise 5-car Train (dBA)	Sound Barrier Wall: Required Distance for Criterion Compliance (ft)
Aerial Structure:								
8+50 to 10+00 (OB)	Commercial (1)	25	50	85	84-86	--	--	--
9+00 to 19+00 (OB)	Mixed Commercial/ Residential (10)	200	50	80	77-79	--	--	--
10+00 to 14+00 (IB)	Commercial (3)	200	50	85	77-79	--	--	--
11+00 to 13+50 (OB)	Mixed Offices/ Residential (4)	75	50	80	82-84**	200	74-76	--
13+00 to 14+00 (OB)	Church	200	50	75	77-79**	400	69-71	--
15+00 to 17+50 (OB)	Commercial (1)	25	50	85	86-88**	75	78-80	--
17+00 to 18+50 (IB)	Commercial (1)	200	50	85	77-79	--	--	--
18+50 to 23+50 (OB)	Olympic High School	250	50	75	76-78**	400	68-70	--
20+00 to 21+50 (OB)	Commercial (1)	150	50	85	79-81	--	--	--

TABLE 6-4 (CONTINUED)

Station Number and Direction from Alignment		Type of Structure (N)*	Distance Near Track to Nearest Building (ft)	Maximum Train Speed (mph)	Criterion for Allowable Levels (dBA)	No Sound Barrier Wall: Predicted Maximum Noise 5-car Train (dBA)	No Sound Barrier Wall: Required Distance for Criterion Compliance (ft)	Sound Barrier Wall: Predicted Maximum Noise 5-car Train (dBA)	Sound Barrier Wall: Required Distance for Criterion Compliance (ft)
20+50 to 23+00	(IB)	Mixed Commercial/ Apartments (6)	25	50	80	86-88	200	78-80	--
22+00 to 23+50	(OB)	Mixed Commercial/ Residential/Offices (4)	50	50	80	84-86	200	76-78	--
24+00 to 33+00	(OB)	Residential (13)	100	50	75	81-83	400	73-75	--
24+00 to 34+00	(IB)	Medical/ Residential/Offices (10)	50	50	80	84-86	200	76-78	--
33+00 to 40+00	(OB)	John F. Baldwin Park	75	50	75	82-84	400	74-76	--
38+50 to 46+00	(IB)	Mt. Diablo Hospital	300	50	75	75-77	400	68-70	--
40+00 to 51+00	(OB)	Residential (16)	50	50	75	84-86	400	76-78**	100
47+50 to 51+00	(IB)	Residential (7)	75	50	75	82-84	400	74-76	--
51+00 to 54+00	(OB)	Residential (5)	35	50	75	85-87	400	78-80**	100

TABLE 6-4 (CONTINUED)

Station Number and Direction from Alignment		Type of Structure (N)*	Distance Near Track to Nearest Building (ft)	Maximum Train Speed (mph)	Criterion for Allowable Levels (dBA)	No Sound Barrier Wall: Predicted Maximum Noise 5-car Train (dBA)	No Sound Barrier Wall: Required Distance for Criterion Compliance (ft)	Sound Barrier Wall: Predicted Maximum Noise 5-car Train (dBA)	Sound Barrier Wall: Required Distance for Criterion Compliance (ft)
51+00 to 54+00	(IB)	Residential (6)	90	50	75	81-83	400	73-75	--
54+00 to 55+50	(OB)	Residential (3)	25	50	75	86-88	400	78-80**	100
54+00 to 55+50	(IB)	Residential (3)	100	50	75	81-83	400	73-75	--
At-Grade:									
55+50 to 58+00	(OB)	Residential (4)	25	50	75	83-85	200	76-78**	50
55+50 to 58+00	(IB)	Residential (4)	100	50	75	77-79	200	70-72	--
Depressed and Cut and Cover Section:									
58+00 to 68+00	(IB/OB)	Residential (27)	25	50	75	71-75	--	--	--
At Grade:									
68+00 to 79+00	(OB)	Residential (15)	25	50	75	83-85	200	76-78**	50
68+00 to 79+00	(IB)	Residential (11)	100	50	75	77-79	200	70-72	--

TABLE 6-4 (CONTINUED)

Station Number and Direction from Alignment		Type of Structure (N)*	Distance Near Track to Nearest Building (ft)	Maximum Train Speed (mph)	Criterion for Allowable Levels (dBA)	No Sound Barrier Wall: Predicted Maximum Noise 5-car Train (dBA)	No Sound Barrier Wall: Required Distance for Criterion Compliance (ft)	Sound Barrier Wall: Predicted Maximum Noise 5-car Train (dBA)	Sound Barrier Wall: Required Distance for Criterion Compliance (ft)
Depressed and Cut and Cover Section:									
79+00 to 91+50	(IB/OB)	Residential (26)	25	50	75	71-75	--	--	--
At Grade: 91+50 to 95+00	(OB)	Residential (6)	25	50	75	83-85	200	76-78**	50
91+50 to 95+00	(IB)	Residential (6)	100	50	75	77-79	200	70-72	--
106+20 to 107+00	(IB)	Preschool	125	50	75	76-78	200	69-71	--
95+00 to 107+00	(OB)	Residential (20)	25	50 @ x-over	75	89-91	500	82-84**	200
108+50 to 120+50	(IB)	Residential (15)	100	50 @ x-over	75	83-85	500	76-78**	200
105+00 to 120+50	(IB)	Residential (21)	100	50	75	77-79	200	70-72	--
107+00 to 116+00	(OB)	Residential (9)	20	50	75	85-87	200	78-80**	50

TABLE 6-4 (CONTINUED)

Station Number and Direction from Alignment		Type of Structure (N)*	Distance Near Track to Nearest Building (ft)	Maximum Train Speed (mph)	Criterion for Allowable Levels (dBA)	No Sound Barrier Wall: Predicted Maximum Noise 5-car Train (dBA)	No Sound Barrier Wall: Required Distance for Criterion Compliance (ft)	Sound Barrier Wall: Predicted Maximum Noise 5-car Train (dBA)	Sound Barrier Wall: Required Distance for Criterion Compliance (ft)
106+20 to 107+00	(IB)	Preschool	125	50	75	76-78	200	69-71	--
110+80 to 111+80	(IB)	Church	100	50	75	77-79	200	70-72	--
120+50 to 129+00	(IB)	Residential (17)	150	50	75	75-77	200	68-70	--
Aerial Structure:									
145+50 to 165+00	(IB)	Golf Course	400	70	80	77-79	--	--	--
At-Grade:									
307+00 to 312+00	(IB)	Residential (8)	450	70	80	72-74	--	--	--
322+00 to 330+00	(IB)	Mobile Homes (20)	250	70	85	76-78	--	--	--
330+00 to 367+00	(IB)	Residential (55)	325	70	80	74-76	--	--	--
367+00 to 387+00	(IB)	Residential (15)	200	50	80	73-75	--	--	--

TABLE 6-4 (CONTINUED)

Station Number and Direction from Alignment		Type of Structure (N)*	Distance Near Track to Nearest Building (ft)	Maximum Train Speed (mph)	Criterion for Allowable Levels (dBA)	No Sound Barrier Wall		Sound Barrier Wall	
						Predicted Maximum Noise 5-car Train (dBA)	Required Distance for Criterion Compliance (ft)	Predicted Maximum Noise 5-car Train (dBA)	Required Distance for Criterion Compliance (ft)
387+00 to 391+00	(IB)	Mixed Commercial/ Mobile Homes (20)	200	70 @ x-over	85	83-85	--	--	--
387+00 to 395+00	(OB)	Residential (10)	125	70 @ x-over	80	86-88	500	77-79	--
391+00 to 397+00	(IB)	Bel Air Elementary School	200	70 @ x-over	75	83-85	800	74-76	--
End Alternative 7A (West Pittsburg Station)									
395+00 to 410+00	(OB)	Ambrose Park	150	70 @ x-over	80	85-87	500	76-78	--
397+00 to 402+00	(IB)	Residential (8)	150	70 @ x-over	80	85-87	500	76-78	--
416+00 to 431+00	(IB)	Residential (30)	150	70	80	79-81	--	--	--
Aerial Structure:									
431+00 to 478+00	(IB)	Residential (100)	150	70	80	83-85	400	73-75	--
437+00 to 477+00	(OB)	Residential (55)	100	70	80	85-87	400	75-77	--

TABLE 6-4 (CONTINUED)

Station Number and Direction from Alignment		Type of Structure (N)*	Distance Near Track to Nearest Building (ft)	Maximum Train Speed (mph)	Criterion for Allowable Levels (dBA)	No Sound Barrier Wall		Sound Barrier Wall	
						Predicted Maximum Noise 5-car Train (dBA)	Required Distance for Criterion Compliance (ft)	Predicted Maximum Noise 5-car Train (dBA)	Required Distance for Criterion Compliance (ft)
At-Grade:									
487+00 to 503+00	(OB)	Residential (12)	200	70	80	77-79	--	--	--
488+00 to 497+00	(IB)	Apartments (17)	125	70	85	79-82	--	--	--
502+00 to 506+00	(IB)	Parkside School	400	70	75	73-75	--	--	--
503+00 to 509+00	(OB)	Los Medanos School	700	70	75	68-70	--	--	--
506+00 to 524+00	(IB)	Residential (30)	150	70	80	79-81	--	--	--
509+00 to 519+00	(OB)	Residential (16)	125	70	80	80-82	--	--	--
519+00 to 524+00	(OB)	Apartments (6)	100	70	85	81-83	--	--	--
524+00 to 538+00	(IB/OB)	Mixed Commercial Apartments (8)	150	50	85	75-77	--	--	--
538+00 to 553+00	(IB)	Mixed Commercial/ Residential (24)	150	70 @ x-over	80	85-87	500	76-78	--

TABLE 6-4 (CONTINUED)

Station Number and Direction from Alignment		Type of Structure (N)*	Distance Near Track to Nearest Building (ft)	Maximum Train Speed (mph)	Criterion for Allowable Levels (dBA)	No Sound Barrier Wall: Predicted Maximum Noise 5-car Train (dBA)	No Sound Barrier Wall: Required Distance for Criterion Compliance (ft)	Sound Barrier Wall: Predicted Maximum Noise 5-car Train (dBA)	Sound Barrier Wall: Required Distance for Criterion Compliance (ft)
538+00 to 553+00	(OB)	Commercial (3)	200	70 @ x-over	85	83-85	--	--	--
553+00 to 624+00	(OB)	Commercial (22)	100	70	85	81-83	--	--	--
553+00 to 556+00	(IB)	Residential (4)	125	70	80	80-82	--	--	--
End Alternative 7B (Pittsburg Station)									
578+00 to 590+00	(IB)	Residential (8)	150	70	80	79-81	--	--	--
590+00 to 638+00	(OB)	Los Medanos College	800	70	75	67-69	--	--	--
655+00 to 671+00	(OB)	Residential (23)	100	50	80	72-79	--	--	--
677+00 to 687+00	(OB)	Kaiser Medical Center	150	70 @ x-over	80	85-87	500	76-78	--
695+00 to 710+00	(IB)	Commercial (10)	125	70	85	80-82	--	--	--
703+00 to 720+00	(OB)	Apartments (17)	150	70	85	79-81	--	--	--

TABLE 6-4 (CONTINUED)

Station Number and Direction from Alignment		Type of Structure (N)*	Distance Near Track to Nearest Building (ft)	Maximum Train Speed (mph)	Criterion for Allowable Levels (dBA)	No Sound Barrier Wall: Predicted Maximum Noise 5-car Train (dBA)	No Sound Barrier Wall: Required Distance for Criterion Compliance (ft)	Sound Barrier Wall: Predicted Maximum Noise 5-car Train (dBA)	Sound Barrier Wall: Required Distance for Criterion Compliance (ft)
710+00 to 727+00	(IB)	Apartments (30)	100	70	85	81-83	--	--	--
720+00 to 735+00	(OB)	Residential (27)	125	70	80	80-82	--	--	--
735+00 to 752+00	(OB)	Mixed Commercial/ Apartments (15)	150	70	85	79-81	--	--	--
748+00 to 753+00	(IB)	Apartments (5)	100	70	85	81-83	--	--	--
753+00 to 760+00	(IB)	John Marsh School	300	70	75	75-77	--	--	--
760+00 to 813+00	(IB))	Residential (75)	200	70	80	77-79	--	--	--
760+00 to 810+00	(OB)	Mixed Commercial/ Apartments (50)	125	70	85	80-85	--	--	--
800+00 to 806+00	(OB)	Roosevelt School	600	70	75	69-71	--	--	--
810+00 to 818+00	(OB)	Residential (12)	150	70	80	79-81	--	--	--
815+00 to 819+00	(IB)	Commercial (2)	200	70	85	77-79	--	--	--

TABLE 6-4 (CONTINUED)

Station Number and Direction from Alignment	Type of Structure (N)*	Distance Near Track to Nearest Building (ft)	Maximum Train Speed (mph)	Criterion for Allowable Levels (dBA)	No Sound Barrier Wall: Predicted Maximum Noise 5-car Train (dBA)	No Sound Barrier Wall: Required Distance for Criterion Compliance (ft)	Sound Barrier Wall: Predicted Maximum Noise 5-car Train (dBA)	Sound Barrier Wall: Required Distance for Criterion Compliance (ft)
Aerial Structure:								
819+00 to 833+00 (IB)	Commercial (15)	200	70	85	81-83	--	--	--
819+00 to 831+00 (OB)	Churches (4)	150	70	75	83-85	400	73-75	--
819+00 to 840+00 (OB)	Residential (50)	800	70	75	71-73	--	--	--
835+00 to 837+00 (IB)	Commercial (3)	25	70	85	90-92	150	78-80	--
837+00 to 840+00 (IB)	Residential (2)	75	70	80	86-88	400	76-78	--

(OB) = Outbound
(IB) = Inbound
*(N) = Number of Buildings ± 10%
** = See Text

TABLE 6-5 AIRBORNE NOISE PROJECTIONS FOR BART ALTERNATIVE 8
(BART TO NORTH CONCORD/MARTINEZ - LRT TO ANTIOCH VIA HIGHWAY 4)

Station Number and Direction from Alignment		Type of Structure (N)*	Distance Near Track to Nearest Building (ft)	Maximum Train Speed (mph)	Criterion for Allowable Levels (dBA)	No Sound Barrier Wall: Predicted Maximum Noise 5-car Train (dBA)	No Sound Barrier Wall: Required Distance for Criterion Compliance (ft)	Sound Barrier Wall: Predicted Maximum Noise 5-car Train (dBA)	Sound Barrier Wall: Required Distance for Criterion Compliance (ft)
Aerial Structure:									
8+50 to 10+00	(OB)	Commercial (1)	25	50	85	84-86	--	--	--
9+00 to 19+00	(OB)	Mixed Commercial/ Residential (10)	200	50	80	77-79	--	--	--
10+00 to 14+00	(IB)	Commercial (3)	200	50	85	77-79	--	--	--
11+00 to 13+50	(OB)	Mixed Offices/ Residential (4)	75	50	80	82-84**	200	74-76	--
13+00 to 14+00	(OB)	Church	200	50	75	77-79**	400	69-71	--
15+00 to 17+50	(OB)	Commercial (1)	25	50	85	86-88**	75	78-80	--
17+00 to 18+50	(IB)	Commercial (1)	200	50	85	77-79	--	--	--
18+50 to 23+50	(OB)	Olympic High School	250	50	75	76-78**	400	68-70	--
20+00 to 21+50	(OB)	Commercial (1)	150	50	85	79-81	--	--	--

TABLE 6-5 (CONTINUED)

Station Number and Direction from Alignment		Type of Structure (N)*	Distance Near Track to Nearest Building (ft)	Maximum Train Speed (mph)	Criterion for Allowable Levels (dBA)	No Sound Barrier Wall: Predicted Maximum Noise 5-car Train (dBA)	No Sound Barrier Wall: Required Distance for Criterion Compliance (ft)	Sound Barrier Wall: Predicted Maximum Noise 5-car Train (dBA)	Sound Barrier Wall: Required Distance for Criterion Compliance (ft)
20+50 to 23+00	(IB)	Mixed Commercial/ Apartments (6)	25	50	80	86-88	200	78-80	--
22+00 to 23+50	(OB)	Mixed Commercial/ Residential/Offices (4)	50	50	80	84-86	200	76-78	--
24+00 to 33+00	(OB)	Residential (13)	100	50	75	81-83	400	73-75	--
24+00 to 34+00	(IB)	Medical/ Residential/Offices (10)	50	50	80	84-86	200	76-78	--
33+00 to 40+00	(OB)	John F. Baldwin Park	75	50	75	82-84	400	74-76	--
38+50 to 46+00	(IB)	Mt. Diablo Hospital	300	50	75	75-77	400	68-70	--
40+00 to 51+00	(OB)	Residential (16)	50	50	75	84-86	400	76-78**	100
47+50 to 51+00	(IB)	Residential (7)	75	50	75	82-84	400	74-76	--
51+00 to 54+00	(OB)	Residential (5)	35	50	75	85-87	400	77-79**	100

TABLE 6-5 (CONTINUED)

Station Number and Direction from Alignment	Type of Structure (N)*	Distance Near Track to Nearest Building (ft)	Maximum Train Speed (mph)	Criterion for Allowable Levels (dBA)	No Sound Barrier Wall: Predicted Maximum Noise 5-car Train (dBA)	No Sound Barrier Wall: Required Distance for Criterion Compliance (ft)	Sound Barrier Wall: Predicted Maximum Noise 5-car Train (dBA)	Sound Barrier Wall: Required Distance for Criterion Compliance (ft)
51+00 to 54+00 (IB)	Residential (6)	90	50	75	81-83	400	73-75	--
54+00 to 55+50 (OB)	Residential (3)	25	50	75	86-88	400	77-79**	100
54+00 to 55+50 (IB)	Residential (3)	100	50	75	81-83	400	73-75	--
At-Grade:								
55+50 to 58+00 (OB)	Residential (4)	25	50	75	83-85	200	76-78**	50
55+50 to 58+00 (IB)	Residential (4)	100	50	75	77-79	200	70-72	--
Depressed and Cut and Cover Section:								
58+00 to 68+00 (IB/OB)	Residential (27)	25	50	75	71-75	--	--	--
At Grade:								
68+00 to 79+00 (OB)	Residential (15)	25	50	75	83-85	200	76-78**	50
68+00 to 79+00 (IB)	Residential (11)	100	50	75	77-79	200	70-72	--

TABLE 6-5 (CONTINUED)

Station Number and Direction from Alignment	Type of Structure (N)*	Distance Near Track to Nearest Building (ft)	Maximum Train Speed (mph)	Criterion for Allowable Levels (dBA)	No Sound Barrier Wall: Predicted Maximum Noise 5-car Train (dBA)	No Sound Barrier Wall: Required Distance for Criterion Compliance (ft)	Sound Barrier Wall: Predicted Maximum Noise 5-car Train (dBA)	Sound Barrier Wall: Required Distance for Criterion Compliance (ft)
Depressed and Cut and Cover Section:								
79+00 to 91+50 (IB/OB)	Residential (26)	25	50	75	71-75	--	--	--
At Grade:								
91+50 to 95+00 (OB)	Residential (6)	25	50	75	83-85	200	76-78**	50
91+50 to 95+00 (IB)	Residential (6)	100	50	75	77-79	200	70-72	--
106+20 to 107+00 (IB)	Preschool	125	50	75	76-78	200	69-71	--
95+00 to 107+00 (OB)	Residential (20)	25	50 @ x-over	75	89-91	500	82-84**	200
108+50 to 120+50 (IB)	Residential (15)	100	50 @ x-over	75	83-85	500	76-78**	200
105+00 to 120+50 (IB)	Residential (21)	100	50	75	77-79	200	70-72	--
107+00 to 116+00 (OB)	Residential (9)	20	50	75	85-87	200	78-80**	50

TABLE 6-5 (CONTINUED)

Station Number and Direction from Alignment		Type of Structure (N)*	Distance Near Track to Nearest Building (ft)	Maximum Train Speed (mph)	Criterion for Allowable Levels (dBA)	No Sound Barrier Wall: Predicted Maximum Noise 5-car Train (dBA)	No Sound Barrier Wall: Required Distance for Criterion Compliance (ft)	Sound Barrier Wall: Predicted Maximum Noise 5-car Train (dBA)	Sound Barrier Wall: Required Distance for Criterion Compliance (ft)
106+20 to 107+00	(IB)	Preschool	125	50	75	76-78	200	69-71	--
110+80 to 111+80	(IB)	Church	100	50	75	77-79	200	70-72	--
120+50 to 129+00	(IB)	Residential (17)	150	50	75	75-77	200	68-70	--

North Concord/Martinez Station (Connection to LRT)

Station Number and Direction from Alignment		Type of Structure (N)*	Distance Near Track to Nearest Building (ft)	Maximum Train Speed (mph)	Criterion for Allowable Levels (dBA)	No Sound Barrier Wall: Predicted Maximum Noise 2-car Train (dBA)	No Sound Barrier Wall: Required Distance for Criterion Compliance (ft)	Sound Barrier Wall: Predicted Maximum Noise 2-car Train (dBA)	Sound Barrier Wall: Required Distance for Criterion Compliance (ft)
307+00 to 367+00	(IB)	Residential (63)	325	60	80	64-67	--	--	--
380+00 to 386+00	(IB/OB)	Residential (6)	250	60 @ x-over	80	73-76	--	--	--
390+00 to 393+00	(OB)	Residential (4)	125	60 @ x-over	80	79-82	200	71-82	--
391+00 to 397+00	(IB)	Bel Air Elementary School	200	60 @ x-over	75	76-78	300	68-70	--

TABLE 6-5 (CONTINUED)

Station Number and Direction from Alignment		Type of Structure (N)*	Distance Near Track to Nearest Building (ft)	Maximum Train Speed (mph)	Criterion for Allowable Levels (dBA)	No Sound Barrier Wall		Sound Barrier Wall	
						Predicted Maximum Noise 2-car Train (dBA)	Required Distance for Criterion Compliance (ft)	Predicted Maximum Noise 2-car Train (dBA)	Required Distance for Criterion Compliance (ft)
396+00 to 420+00	(OB)	Ambrose Park	150	60 @ x-over	80	77-80	--	--	--
399+00 to 403+00	(IB)	Residential (7)	150	60	80	77-80	--	--	--
Aerial Structure:									
432+00 to 478+00	(IB)	Residential (100)	150	60	80	76-79	--	--	--
438+00 to 478+00	(OB)	Residential (55)	100	60	80	79-82	--	--	--
At Grade:									
489+00 to 498+00	(IB)	Apartments (17)	125	60	85	73-76	--	--	--
506+00 to 524+00	(IB/OB)	Residential (46)	125	60	80	73-76	--	--	--
545+00 to 549+00	(IB)	Residential (9)	150	60 @ x-over	80	77-80	--	--	--
554+00 to 591+00	(IB)	Residential (12)	125	60	80	73-76	--	--	--
656+00 to 672+00	(OB)	Residential (23)	100	50	80	72-75	--	--	--

TABLE 6-5 (CONTINUED)

Station Number and Direction from Alignment		Type of Structure (N)*	Distance Near Track to Nearest Building (ft)	Maximum Train Speed (mph)	Criterion for Allowable Levels (dBA)	No Sound Barrier Wall: Predicted Maximum Noise 2-car Train (dBA)	No Sound Barrier Wall: Required Distance for Criterion Compliance (ft)	Sound Barrier Wall: Predicted Maximum Noise 2-car Train (dBA)	Sound Barrier Wall: Required Distance for Criterion Compliance (ft)
End of Alternative 4A (West Antioch Station									
678+00 to 688+00	(OB)	Kaiser Medical Center	150	60	80	71-74	--	--	--
704+00 to 754+00	(IB/OB)	Apartments (52)	100	60	85	74-77	--	--	--
721+00 to 736+00	(OB)	Residential (27)	125	60	80	73-76	--	--	--
761+00 to 811+00	(OB)	Mixed Commercial/ Apartments (50)	125	60	85	73-76	--	--	--
Aerial Structure:									
820+00 to 832+00	(OB)	Churches (4)	150	60	80	71-74	--	--	--
836+00 to 838+00	IB)	Commercial (3)	25	60	85	85-88	75	76-79	--
838+00 to 841+00	(IB)	Residential (2)	75	60	80	81-84	150	72-75	--

(OB) = Outbound
(IB) = Inbound
*(N) = Number of Buildings ± 10%
** = See Text

TABLE 6-6 SELECTED AMBIENT AND PREDICTED WAYSIDE NOISE LEVELS FOR PITTSBURG-ANTIOCH CORRIDOR ALTERNATIVE 4 (LRT to Antioch via Highway 4)

Station Number	Transit Structure	Type and Quantity of Noise Sensitive Buildings	Distance to Nearest Track (feet)	Passby Noise Criterion (dBA)	Existing Condition (1988)		Predicted Operational Noise Levels* (2000)		
					L_{eq} (dBA)	L_{dn} (dBA)	Passby (dBA)	L_{eq} (dBA)	L_{dn} (dBA)
<u>ALTERNATIVE 4</u> (LRT to Antioch via Highway 4)									
40+00/51+00 (OB)	A	Residential (16)	50	75	62-64	64-66	70-73	64-66	66-68
40+00/51+00 (OB)	A	Residential (16)	200	75	54-56	55-57	61-64	56-58	57-59
84+00/114+00 (OB)	B&T	Residential (44)	25	75	62-64	64-66	71-74	64-66	66-68
390+00/393+00 (OB)	B&T x-over	Residential (4)	125	80	64-66	68-70	71-74	66-68	70-72
391+00/397+00 (IB)	B&T x-over	Elementary School	200	75	62-64	66-68	67-70	64-66	68-70

A = Aerial, B&T = Ballast & Tie, IB = in-bound, OB = out-bound, x-over = crossover
* = with sound barrier wall on way structure, L_{eq} = L_{eq} (peak hour), Passby = maximum passby level

TABLE 6-7 SELECTED AMBIENT AND PREDICTED WAYSIDE NOISE LEVELS FOR PITTSBURG-ANTIOCH CORRIDOR ALTERNATIVE 5 (LRT to Antioch via Highway 4 and SPRR)

Station Number	Transit Structure	Type and Quantity of Noise Sensitive Buildings	Distance to Nearest Track (feet)	Passby Noise Criterion (dBA)	Existing Condition (1988)		Predicted Operational Noise Levels* (2000)		
					L_{eq} (dBA)	L_{dn} (dBA)	Passby (dBA)	L_{eq} (dBA)	L_{dn} (dBA)
40+00/51+00 (OB)	A	Residential (16)	50	75	62-64	64-66	70-73	64-66	66-68
40+00/51+00 (OB)	A	Residential (16)	200	75	54-56	55-57	61-64	56-58	57-59
84+00/114+00 (OB)	B&T	Residential (44)	25	75	62-64	64-66	71-74	64-66	66-68
390+00/393+00 (OB)	B&T x-over	Residential (4)	125	80	64-66	68-70	71-74	66-68	70-72
391+00/397+00 (IB)	B&T x-over	Elementary School	200	75	62-64	66-68	67-70	64-66	68-70
352+00/360+00 (IB)	A	Residential (14)	75	75	59-61	61-64	71-74	60-62	64-66
589+00/595+00 (IB/OB)	B&T x-over	Residential (18)	75	75	56-58	58-60	74-77	58-60	60-62
770+00/792+00 (OB)	B&T	Residential (36)	50	75	57-59	59-61	70-73	61-63	61-63

A = Aerial, B&T = Ballast & Tie, IB = in-bound, OB = out-bound, x-over = crossover
* = with sound barrier wall on way structure, L_{eq} = L_{eq} (peak hour), Passby = maximum passby level

TABLE 6-8 SELECTED AMBIENT AND PREDICTED WAYSIDE NOISE LEVELS FOR PITTSBURG-ANTIOCH CORRIDOR ALTERNATIVE 6 (BART to North Concord/Martinez)

Station Number	Transit Structure	Type and Quantity of Noise Sensitive Buildings	Distance to Nearest Track (feet)	Passby Noise Criterion (dBA)	Existing Condition (1988)		Predicted Operational Noise Levels* (2000)		
					L_{eq} (dBA)	L_{dn} (dBA)	Passby (dBA)	L_{eq} (dBA)	L_{dn} (dBA)
40+00/51+00 (OB)	A	Residential (16)	50	75	62-64	64-66	78-80	68-70	67-69
40+00/51+00 (OB)	A	Residential (16)	200	75	54-56	55-57	71-73	60-62	59-61
91+50/95+00 (OB)	B&T	Residential (6)	25	75	62-64	64-66	78-80	68-70	67-69
95+00/107+00 (OB)	B&T x-over	Residential (20)	25	75	62-64	64-66	84-86	72-74	70-72
107+00/116+00 (OB)	B&T	Residential (9)	20	75	62-64	64-66	80-82	69-71	68-70

A = Aerial, B&T = Ballast & Tie, IB = in-bound, OB = out-bound, x-over = crossover
* = with sound barrier wall on way structure, L_{eq} = L_{eq} (peak hour), Passby = maximum passby level

TABLE 6-9 SELECTED AMBIENT AND PREDICTED WAYSIDE NOISE LEVELS FOR PITTSBURG-ANTIOCH CORRIDOR ALTERNATIVE 7 (BART to Antioch via Highway 4)

Station Number	Transit Structure	Type and Quantity of Noise Sensitive Buildings	Distance to Nearest Track (feet)	Passby Noise Criterion (dBA)	Existing Condition (1988)		Predicted Operational Noise Levels* (2000)		
					L_{eq} (dBA)	L_{dn} (dBA)	Passby (dBA)	L_{eq} (dBA)	L_{dn} (dBA)
40+00/51+00 (OB)	A	Residential (16)	50	75	62-64	64-66	76-78	66-68	67-69
40+00/51+00 (OB)	A	Residential (16)	200	75	54-56	55-57	69-71	59-61	58-60
91+50/95+00 (OB)	B&T	Residential (6)	25	75	62-64	64-66	76-78	66-68	67-69
95+00/107+00 (OB)	B&T x-over	Residential (20)	25	75	62-64	64-66	82-84	69-71	68-70
107+00/116+00 (OB)	B&T	Residential (9)	20	75	62-64	64-66	78-80	67-69	67-69
387+00/395+00 (OB)	B&T x-over	Residential (10)	125	80	64-66	68-70	77-79	68-70	70-72
391+00/397+00 (IB)	B&T x-over	Elementary School	200	75	62-64	66-68	74-76	66-68	68-70
431+00/478+00 (IB/OB)	A	Residential (155)	100	80	65-67	69-71	75-77	67-69	70-72

A = Aerial, B&T = Ballast & Tie, IB = in-bound, OB = out-bound, x-over = crossover
* = with sound barrier wall on way structure, L_{eq} = L_{eq} (peak hour), Passby = maximum passby level

7. YARD NOISE

7.1 General

There are no plans currently available for the East Antioch Yard. When yard details are known, a further analysis of noise should be performed. The activities in a storage and maintenance yard result in noise due to a number of sources, as given in the following listing of the major sources.

Wheel squeal on curves,

Clicks and pings as wheels pass over rail joints and through switches,

Train rolling noise,

Transit car auxiliary equipment operation,

Coupling and decoupling of cars,

Train horns,

Workmen shouting, and

Telephone or warning buzzers or horns, announcement or call loudspeakers and noise created by maintenance work.

There are two additional sources of noise that have been encountered in yard operations but that are not included in the above list because they do not occur with the BART or LRT Vehicles. The sound of brakes squealing and the sound of air release frequently encountered with air brakes or dumping cycles of air compressor and air brake systems. Both of these sources of

noise are not present as significant noise sources on modern transit vehicles because of the use of quiet operating brakes and the use of systems which do not require dumping of air in the operating cycle, thus eliminating the characteristic air release sound.

The principal noises which have been found to create annoyance in residential areas near transit system yards are the noise from the transit cars:

1. The noise from auxiliary equipment on the cars,

2. The noise from car propulsion systems and the wheel and rail interaction when the cars are moving on the track,

3. The pings, clicks and bangs which occur as wheels pass through switches and over frogs and joints in the special trackwork included in the yard and,

4. The wheel squeal which results when the cars move on short radius tracks or on a turnaround track.

These sources produce randomly occurring noises which are of considerably different character than typical community background noise and, therefore, if of sufficient level they can be noticeable and intrusive. Most of the noise produced by the transit vehicles themselves is controlled (due to the specification requirements for in-car noise and subway station platform noise of new stations) to a level that will avoid impact on adjacent areas unless the separation distance from the yard and the residential or other noise critical area is very small.

All auxiliary equipment on modern transit cars are required to meet a specification of 68 dBA at 15 ft from each individual item. With all equipment operating the maximum allowable noise level is

60 dBA 50 ft from the center of the vehicle. With older vehicles it has been found that air compressors and other items which operate either constantly or cyclicly can typically produced noise levels as high as 75 to 80 dBA at 15 ft from the car. The noise limit specifications on auxiliary equipment for the latest vintage Bart and LRT rail transit vehicles will eliminate these noises as sources of impact in the community near the East Antioch Yard.

Train speeds in yards are generally limited to the range of 15 to 20 mph maximum so that noise from the trains rolling is generally a maximum of 70 dBA at 50 ft and usually is considerably less - in the range of 60 to 65 dBA at 50 ft. Because of the noise limit specifications on vehicle auxiliary and propulsion equipment and because of low speeds of operation in yards, the general rolling noise due to train operations on tangent track does not result in any impact in adjacent communities and is comparable with and compatible with typical community background noise.

Table 7-1 indicates typical noise levels expected at 50, 100, 300 and 600 ft from 2-car trains stopped or moving on tangent yard tracks. Noise levels for a longer train consist will be somewhat higher. Included are the expected levels when the noise is shielded by a sound barrier wall. It should be noted that the nearest residential buildings would appear to be at large distances from the yard based on information available at this time. At these distances, when considering both the noise levels from the trains and the existing noise levels, there should be no noise impact from most yard activities even without the use of sound barrier walls.

7.2 Wheel Squeal From Yard

A potential noise impact from the East Antioch Yard is the wheel squeal which can result from the transit trains moving on short radius and turnaround tracks. In order to minimize squeal

occurrence on the yard curves, the curves should have a radius greater than 400 ft. Due to space constraints, this may not be possible, however, the radius of the curves should be maximized.

Since there is the possibility of annoyance due to the wheel squeal one or more of the following recommendations should be considered in order to minimize this potential problem:

1. Maximize the radius of curves in the yard. Curve radius should be greater than 400 ft, if possible.

2. Minimize the number of curves in the yard

3. Minimize train speed on curves

4. Install a sound barrier wall or earth berm on the side of the yard near any short radius curves

5. Lubricate tight radius curves

Although lubrication can be very effective in reducing the frequency of squeal occurrence, past experience has indicated a very strong resistance by most transit agencies to consider rail lubrication as a viable alternative to eliminate squeal. One of the major problems is maintaining the lubricating equipment so that the lubricant remains confined to the side of the rail and the wheel flange area and does not migrate to the top of the rail which can cause loss of traction and/or wheel flats due to sliding of wheels. In those areas where rail lubricating devices are used, the life of wheel flanges and rail is extended, but the degree of wheel squeal reduction is dependent on the status of the equipment. Water spray lubrication has also been used and found to be relatively effective.

TABLE 7-1 NOISE LEVELS FROM 2-CAR TRAINS OPERATING ON YARD TRACKS

	Distance from Track Centerline			
Noise Source	50 ft	100 ft	300 ft	600 ft
Car Stationary				
Auxiliaries Operating	61 dBA	57 dBA	47 dBA	41 dBA
Train Moving at 20 mph				
Aerial Structure:				
- No Shielding	73	69	60	54
- With Sound Barrier Wall	68	64	55	49
Ballast and Tie:				
- No Shielding	70	66	57	51
- With Sound Barrier Wall	62	58	49	43
- Deep Cut	55	51	42	36

8. VIBRATION LEVELS FROM SURFACE AND AERIAL STRUCTURE OPERATIONS

8.1 General

Operations of rail transit systems result in ground-borne vibration which is transmitted from the track structure to the adjacent buildings via the intervening geologic strata. The ground-borne vibration originates at the wheel/rail interface and is due to the vibration generated by the wheels rolling on the rails. The level of this vibration at the source is influenced by the degree of roughness or smoothness of the wheels and rails, the stiffness of the transit vehicle primary suspension, the speed of the train, the type of track fixation, and by the geologic strata in which the alignment is situated.

Inside nearby buildings, if the airborne component of noise from a transit train is sufficiently attenuated, then ground-borne noise can be perceived as a low pitched rumbling noise radiated inside the building structure by the ground-borne induced vibration of the building's walls, floors and ceilings. However, as previously noted in Chapter 6, in virtually all cases along the Pittsburg-Antioch Corridor alternative alignments, the airborne noise will be of sufficient level to mask the ground-borne noise and the only potential impact from ground-borne vibration is the perception of low level mechanical motion.

It should be noted that the wayside vibration is of such a low level that there is no possibility or potential for structural damage due to the ground-borne vibration transmitted to buildings near the alignment.

In the past, the general belief was that, for at-grade and aerial structure operations of transit trains at modern systems, the ground-borne vibration created was of such a low level that there

was no possibility of vibration impact. Furthermore, it was thought that major vibration impact only occurs for subway operations located very near adjacent buildings. Experience within the transit industry over past 10 to 15 years has shown that this is not necessarily true. Significant levels of ground-borne vibration can be generated for at-grade and aerial structure operations under certain conditions. Consequently, general statements concerning vibration impact are not possible unless the nearest buildings are obviously far enough away from the alignment.

What distance is far enough is very site and transit system dependent. The magnitude of wayside building vibration is dependent, to a large degree, on local soil conditions. Other factors that are significant are the vibrational characteristics of the transit vehicle, the type of way structure, the rail roughness and the type of building affected. Specific knowledge of the relative importance of these parameters is necessary before even general statements can be made.

More detailed data are required in order to predict, with any accuracy, expected levels of ground-borne vibration within nearby buildings. For the alternative rail systems being studied for Pittsburg-Antioch Corridor, there exists a relatively detailed data base on the vibrational characteristics of the vehicles being considered. In addition, there are measured data on the wayside vibration adjacent to different way structures of the existing BART system. Although no vibration propagation tests have been performed along the alignments under study, wayside vibration measurements have been made adjacent to BART facilities very near the Corridor area. Combination of these data make possible prediction of expected ground-borne vibration for the alternative alignments.

Similar to the case with wayside noise, standard switch frogs normally used at crossovers, due to the inherent gap are sources of high levels of ground-borne vibration compared with operation on adjacent trackwork. To achieve acceptable levels of ground-borne vibration in buildings close to rail alignments, it is necessary to locate crossovers as far from vibration sensitive buildings (e.g., residences, hospitals) as practical, preferably in industrial or undeveloped areas. Where operational requirements of the transit system require siting close to vibration sensitive buildings, then use of special switch frogs will minimize vibration impact at these locations.

8.2 Ground-borne Vibration For BART and LRT Operations

Predicted ground-borne vibration levels for the alternative alignments are based on past measurements made adjacent to BART aerial structure (Ref. 13), at-grade ballast and tie track (Ref. 11), and subway (Ref. 11) (for cut-and-cover sections) facilities. LRT vibration levels are based on design data for the Guadalupe Corridor Project (Ref. 10). No predictions for ground-borne noise are necessary, because all but short sections of track are at-grade or on aerial structure, and airborne wayside noise should dominate in these instances. Although sufficiently accurate for the purpose of impact analysis, the predictions of ground-borne vibration are estimates and require refinement in the engineering phase of the project. Measurements of site soil and building characteristics are needed to more accurately specific requirements of vibration reduction features where needed.

Predicted wayside vibration levels for each of the Alternatives are given in Tables 8-1 through 8-4. As was done for noise predictions, the closest building or group of buildings to the alignment is used to make projections of ground-borne vibration at

stations along each alignment. Discussion of ground-borne vibration predictions for each alternative follows. The criteria for acceptable vibration levels are presented in Chapter 5 and are a function of building use and type of area in which located.

Alternative 4 (LRT to Antioch via Highway 4)

The predicted ground-borne vibration levels for this alternative are presented in Table 8-1. As can be seen, the vibration levels, inside residences within 50 ft of the aerial structure, along Port Chicago Highway, are expected to exceed the criterion, unless some form of vibration reduction feature is installed. This occurs on the outbound side of the alignment between stations 40+00 to 55+50. Actual houses affected will depend on the location of aerial structure support columns. Installation of special resilient fasteners is expected to reduce vibration to nearly imperceptible levels, except for five houses, some of which could be within 30 ft to 40 ft of support columns. Vibration levels inside these houses may be barely perceptible, but should not result in any significant impact.

For the at-grade section of the Port Chicago Highway alignment segment, vibration levels inside residences on the east side of the highway and 25 ft from the near track, are expected to be perceptible unless special measures are implemented. Use of a specially designed "ballast mat", placed under the ballast, has recently been shown to be effective in reducing vibration from ballast and tie track installations. A ballast mat or other equally effective vibration measure could be used to produce acceptable ground-borne vibration levels between station 55+50 and 116+00 for this alternative.

The remainder of this alignment is in the median of Highway 4. Higher criteria levels specified for this part of the alignment are consistent with higher existing ambient levels of vibration. This factor and the greater distances to residences and other sensitive buildings result in acceptable vibration levels with use of standard trackwork from station 116+00 to the East Antioch Station.

Alternative 5 (LRT to Antioch via Highway 4 and SPRR)

The vibration impact for the Port Chicago Highway portion of this alternative, as indicated by the predictions in Table 8-2, will be the same as for Alternative 4. The requirements for vibration reduction, where indicated, will be the same for this section.

Along the SPTC portion of the alignment, the closest houses are 50 ft and LRT speeds along that section are nearly double other sections of the alignment. However, the residences adjacent to the railroad track, as indicated in the discussion of the existing ambient vibration, are currently exposed to levels of vibration from freight traffic that should be perceptible. Consequently, ground-borne vibration criteria for transit operation are somewhat higher than in other areas of the alignment.

The combined effect of these factors should result in acceptable levels of LRT ground-borne vibration in adjacent residences, if standard ballast and tie track is used. However, at crossovers the use of standard switch frogs will, as with noise, result in substantially higher levels of ground-borne vibration.

It may not be possible to reduce vibration levels adequately, at crossover points with standard frogs, even with use of a special ballast mat as discussed under Alternative 4. Unless special switch frogs are used to reduce high levels of impact at switches,

it may be necessary to use a floating slab form of isolation for these sections. If this is found to be the case during the engineering design of the alignment, it may be necessary to use a sound barrier wall with absorption or a floating slab design with ballast to produce acceptable levels of wayside noise.

Alternative 6 (BART to North Concord/Martinez)

The impact from ground-borne vibration on nearby residential dwellings is expected to be significant for this alternative, unless special vibration reduction measures are implemented. The vibration levels from BART operation will be significantly higher than for the LRT, due to greater vehicle speeds and in part to longer trains and different vehicle characteristics. Predicted vibration levels are given in Table 8-3.

For areas where residences are within 50 ft of aerial structure support columns, which occurs along Port Chicago Highway, the predicted vibration levels are high enough to warrant use of special resilient fasteners for vibration isolation of the rails. Where residences are within 25 ft of support columns, it may also be necessary to isolate the guideway in addition to using special rail fasteners in order to produce acceptable levels of vibration. There are three to five houses, between station 53+00 and 55+50, where inside vibration levels may be barely perceptible, but no significant impact is expected.

For the depressed and cut-and-cover sections of the Port Chicago Highway alignment ground-borne vibration levels are expected to be excessive and definitely perceptible in residences 25 ft from the alignment on the east side of the highway unless vibration reduction measures are installed. Special resilient fasteners or other vibration reduction measures will be needed to produce

acceptable levels of vibration in nearby residences. For at-grade sections in this area, it may be necessary to resort to vibration isolation that is achievable only with a floating slab type track support. This should reduce ground-borne vibration levels in residences at 25 ft from the near track to be essentially imperceptible. A ballast mat in this area may not provide enough reduction and is, therefore, not recommended. To avoid creating higher noise levels, it may be necessary to use a sound barrier wall with absorption or a floating ballast "tub" type isolation. Use of a resiliently supported slab would increase wayside noise levels, particularly at low frequencies.

Even with use of special vibration isolation measures, vibration levels within 25 ft of standard switch frogs do not achieve criterion compliance. As previously discussed, it may be necessary to use special frogs at the crossover points in the Port Chicago section of the alignment or move the crossover to another location away from houses.

<u>Alternative 7 (BART to Antioch via Highway 4)</u>

The impact from ground-borne vibration along the Port Chicago Highway section of the alignment is only slightly less than that for Alternative 6, due to shorter trains. Therefore, the same vibration reduction measures could be needed for this alternative.

The houses along the Highway 4 portion of the alignment are far enough away for ground-borne vibration levels to be sufficiently attenuated when standard ballast and tie track is used. No special vibration isolation measures should be needed for the Highway 4 portion of the alignment, except where crossover points are located within 200 ft of residences and other vibration sensitive buildings. For the residences between station 387+00

and 395+00 and Kaiser Medical Center between station 677+00 and 687+00, use of special switch frogs, for the crossovers in these two locations, should result in acceptable vibration levels.

Alternative 8 (BART to North Concord/Martinez and LRT to Antioch via Highway 4)

This alternative is a combination of BART up to the proposed North Concord/Martinez Station and LRT thereafter to West Antioch via the median of Highway 4. The operational parameters are those of Alternative 7 for BART and Alternative 4 for LRT. The requirements for vibration reduction for the Port Chicago Highway section are discussed under Alternatives 4 and 7.

8.3 Vibration Reduction Measures

As indicated, the ground-borne vibration from BART and LRT train operations on the Alternative Alignments is expected to have a significant impact in some areas without appropriate special vibration reduction features. With the use of the vibration reduction features indicated in Tables 8-1 through 8-4 and in the discussion of each Alternative, ground-borne vibration inside buildings adjacent to the alignment can be sufficiently reduced to avoid major vibration impact. As with the recommended noise reduction features, specific methods which will be used can be determined during a subsequent engineering analysis and design phase.

TABLE 8-1 SUMMARY OF PROJECTED MAXIMUM GROUND-BORNE VIBRATION LEVELS FROM TRANSIT TRAIN OPERATIONS ALTERNATIVE 4 (LRT TO ANTIOCH VIA HIGHWAY 4)

Location of Structure Adjacent to Alignment		Type of Structure (N)	Transit Structure	Horiz. Distance from Near Track ℄ (ft)	Operat'l Train Speed (mph)	Ground-Borne Vibration: Criterion for Allowable Vibration Level (dB)*	Ground-Borne Vibration: Projected Maximum Vibration Veloc. Lvl. (dB)*	Ground-Borne Vibration: Projected Maximum Vibration Veloc. Lvl. With Recomm. Vib. Reduction (dB)*
8+50 to 17+35	(OB)	Commercial (2)	A	25	35	80	68-73	--
20+35 to 23+00	(IB)	Mixed Commercial/ Apartments (6)	A	25	35	80	70-75	--
22+00 to 34+00	(OB)	Mixed Commercial/ Residential/Offices (14)	A	50	35	75	66-71	--
40+00 to 51+00	(OB)	Residential (16)	A	50	35	70	67-72	63-68[1]
51+00 to 54+00	(OB)	Residential (15)	A	35	35	70	68-74	65-70[1]
54+00 to 55+35	(OB)	Residential (3)	A	25	35	70	71-76	67-72[1]
55+35 to 109+00	(OB)	Residential (74)	B&T	25	50	70	69-74	64-69[2]
109+00 to 116+00	(OB)	Residential (8)	B&T	20	35	70	70-75	65-70[2]
390+00 to 393+00	(OB)	Residential (3)	B&T	125	60 @ x-over	75	67-72	--

TABLE 8-1 (CONTINUED)

Location of Structure Adjacent to Alignment		Type of Structure (N)	Transit Structure	Horiz. Distance from Near Track ℄ (ft)	Operat'l Train Speed (mph)	Ground-Borne Vibration: Criterion for Allowable Vibration Level (dB)*	Ground-Borne Vibration: Projected Maximum Vibration Veloc. Lvl. (dB)*	Ground-Borne Vibration: Projected Maximum Vibration Veloc. Lvl. With Recomm. Mitigation (dB)*
656+00 to 754+00	(IB/OB)	Residential/ Apartments (75)	B&T	100	60	75	60-65	--
678+00 to 688+00	(OB)	Kaiser Medical Center	B&T	150	60 @ x-over	70	62-67	--
838+00 to 841+00	(IB)	Residential (2)	A	75	60	75	57-62	--

Key:
A = Aerial structure
B&T = At-Grade ballast and tie
D/C&C = Depressed and cut-and-cover
x-over = Crossover
(N) = Number of buildings ± 10%
** = See text
* = dB re: 1 micro in/sec

Vibration Reduction Measures

1 Special resilient fasteners
2 Ballast mat
3 Floating ballast tub
4 Guideway/column isolator
5 Special switch frog

TABLE 8-2 SUMMARY OF PROJECTED MAXIMUM GROUND-BORNE VIBRATION LEVELS FROM TRANSIT TRAIN OPERATIONS ALTERNATIVE 5 (LRT TO ANTIOCH VIA HIGHWAY 4 AND SPRR)

Location of Structure Adjacent to Alignment		Type of Structure (N)	Transit Structure	Horiz. Distance from Near Track ℄ (ft)	Operat'l Train Speed (mph)	Ground-Borne Vibration: Criterion for Allowable Vibration Level (dB)*	Ground-Borne Vibration: Projected Maximum Vibration Veloc. Lvl. (dB)*	Ground-Borne Vibration: Projected Maximum Vibration Veloc. Lvl. With Recomm. Vib. Reduction (dB)*
8+50 to 17+50	(OB)	Commercial (2)	A	25	35	80	68-73	--
20+50 to 23+00	(IB)	Mixed Commercial/ Apartments (6)	A	25	35	80	70-75	--
22+00 to 34+00	(OB)	Mixed Commercial/ Residential/Offices (14)	A	50	35	75	66-71	--
40+00 to 51+00	(OB)	Residential (16)	A	50	35	70	67-72	63-68[1]
51+00 to 54+00	(OB)	Residential (15)	A	35	35	70	68-74	65-70[1]
54+00 to 55+50	(OB)	Residential (3)	A	25	35	70	71-76	67-72[1]
55+50 to 109+00	(OB)	Residential (76)	B&T	25	35	70	69-74	64-69[2]
109+00 to 116+00	(OB)	Residential (8)	B&T	20	35	70	70-75	65-70[2]
586+00 to 589+00	(IB/OB)	Residential (79)	B&T	75	60	75	66-71	--

TABLE 8-2 CONTINUED

Location of Structure Adjacent to Alignment		Type of Structure (N)	Transit Structure	Horiz. Distance from Near Track ℄ (ft)	Operat'l Train Speed (mph)	Ground-Borne Vibration: Criterion for Allowable Vibration Level (dB)*	Projected Maximum Vibration Veloc. Lvl. (dB)*	Projected Maximum Vibration Veloc. Lvl. With Recomm. Vib. Reduction (dB)*
589+00 to 595+00	(IB/OB)	Residential (18)	B&T	75	60 @ x-over	75	76-81	66-71[5]
770+00 to 835+00	(OB)	Residential (81)	B&T	50	60	75	69-74	--

Key:
- A = Aerial structure
- B&T = At-Grade ballast and tie
- D/C&C = Depressed and cut-and-cover
- x-over = Crossover
- (N) = Number of buildings ± 10%
- ** = See text
- * = dB re: 1 micro in/sec

Vibration Reduction Measures

1. Special resilient fasteners
2. Ballast mat
3. Floating ballast tub
4. Guideway/column isolator
5. Special switch frog

TABLE 8-3 SUMMARY OF PROJECTED MAXIMUM GROUND-BORNE VIBRATION LEVELS FROM TRANSIT TRAIN OPERATIONS ALTERNATIVE 6 (BART TO NORTH CONCORD/MARTINEZ) AND ALTERNATIVE 7 (BART TO ANTIOCH VIA HIGHWAY 4)

Location of Structure Adjacent to Alignment		Type of Structure (N)	Transit Structure	Horiz. Distance from Near Track ℄ (ft)	Operat'l Train Speed (mph)	Ground-Borne Vibration		
						Criterion for Allowable Vibration Level (dB)*	Projected Maximum Vibration Veloc. Lvl. (dB)*	Projected Maximum Vibration Veloc. Lvl. With Recomm. Vib. Reduction (dB)*
8+50 to 17+50	(OB)	Commercial (2)	A	25	50	80	73-78	--
20+50 to 23+00	(IB)	Mixed Commercial/ Apartments (6)	A	25	50	80	75-80	--
22+00 to 34+00	(IB)	Mixed Commercial/ Residential/Offices (14)	A	50	50	75	71-76	--
40+00 to 51+00	(OB)	Residential (16)	A	50	50	70	72-77	65-70[1,4]
51+00 to 54+00	(OB)	Residential (15)	A	35	50	70	74-79	67-72[1,4]
54+00 to 55+50	(OB)	Residential (3)	A	25	50	70	76-81	69-74[1,4]**
55+50 to 58+00	(OB)	Residential (4)	B&T	25	50	70	74-79	65-70[3]
58+00 to 68+00	(OB)	Residential (13)	D/C&C	25	50	70	73-78	69-74[1]**
68+00 to 79+00	(OB)	Residential (15)	B&T	25	50	70	74-79	65-70[3]

TABLE 8-3 (CONTINUED)

Location of Structure Adjacent to Alignment		Type of Structure (N)	Transit Structure	Horiz. Distance from Near Track C (ft)	Operat'l Train Speed (mph)	Ground-Borne Vibration: Criterion for Allowable Vibration Level (dB)*	Projected Maximum Vibration Veloc. Lvl. (dB)*	Projected Maximum Vibration Veloc. Lvl. With Recomm. Mitigation (dB)*
77+00 to 91+50	(OB)	Residential (13)	D/C&C	25	50	70	73-78	69-74[1]**
91+50 to 96+00	(OB)	Residential (8)	B&T	25	50	70	74-79	65-70[3]
96+00 to 103+00	(OB)	Residential (13)	B&T	25	50 @ x-over	70	84-89	65-70[3,5]
96+00 to 103+00	(IB)	Residential (5)	B&T	100	50 @ x-over	70	73-78	54-59[3,5]
103+00 to 109+00	(OB)	Residential (10)	B&T	25	50	70	74-79	65-70[3]
109+00 to 116+00	(OB)	Residential (8)	B&T	20	50	70	75-80	66-71[3]
END ALTERNATIVE 6 (North Concord/Martinez Station)								
320+00 to 835+00	(IB/OB)	Residential/ Apartments (114)	B&T	125	70	75	62-67	--
387+00 to 395+00	(OB)	Residential (10)	B&T	125	70 @ x-over	75	73-78	63-68[5]
677+00 to 687+00	(OB)	Kaiser Medical Center	B&T	150	70 @ x-over	70	69-74	69-74[5]

TABLE 8-3 (CONTINUED)

Location of Structure Adjacent to Alignment		Type of Structure (N)	Transit Structure	Horiz. Distance from Near Track C (ft)	Operat'l Train Speed (mph)	Ground-Borne Vibration: Criterion for Allowable Vibration Level (dB)*	Ground-Borne Vibration: Projected Maximum Vibration Veloc. Lvl. (dB)*	Ground-Borne Vibration: Projected Maximum Vibration Veloc. Lvl. With Recomm. Mitigation (dB)*
710+00 to 753+00	(IB)	Apartments (35)	B&T	100,	70	75	66-71	--
835+00 to 837+00	(IB)	Commercial (3)	A	30	70	80	74-79	--
837+00 to 840+00	(IB)	Residential (2)	A	75	70	75	64-69	--

A = Aerial structure
B&T = At-Grade ballast and tie
D/C&C = Depressed and cut-and-cover
x-over = Crossover
(N) = Number of buildings ± 10%
** = See text
* = dB re: 1 micro in/sec

Vibration Reduction Measures

1 Special resilient fasteners
2 Ballast mat
3 Floating ballast tub
4 Guideway/column isolator
5 Special switch frog

TABLE 8-4 SUMMARY OF PROJECTED MAXIMUM GROUND-BORNE VIBRATION LEVELS FROM TRANSIT TRAIN OPERATIONS ALTERNATIVE 8 (BART TO NORTH CONCORD/MARTINEZ - LRT TO ANTIOCH VIA HIGHWAY 4)

Location of Structure Adjacent to Alignment		Type of Structure (N)	Transit Structure	Horiz. Distance from Near Track ¢ (ft)	Operat'l Train Speed (mph)	Ground-Borne Vibration: Criterion for Allowable Vibration Level (dB)*	Ground-Borne Vibration: Projected Maximum Vibration Veloc. Lvl. (dB)*	Ground-Borne Vibration: Projected Maximum Vibration Veloc. Lvl. With Recomm. Vib. Reduction (dB)*
8+50 to 17+50	(OB)	Commercial (2)	A	25	50	80	73-78	--
20+50 to 34+00	(IB)	Mixed Commercial/ Apartments (6)	A	25	50	80	75-80	--
22+00 to 23+50	(OB)	Mixed Commercial/ Residential/Offices (14)	A	50	50	75	71-76	--
40+00 to 51+00	(OB)	Residential (16)	A	50	50	70	72-77	65-70[1,4]
51+00 to 54+00	(OB)	Residential (15)	A	35	50	70	74-79	67-72[1,4]
54+00 to 55+50	(OB)	Residential (3)	A	25	50	70	76-81	69-74[1,4]
55+50 to 58+00	(OB)	Residential (4)	B&T	25	50	70	74-79	65-70[3]
58+00 to 68+00	(OB)	Residential (13)	D/C&C	25	50	70	73-78	69-74[1]**
68+00 to 79+00	(OB)	Residential (15)	B&T	25	50	70	74-79	65-70[3]

TABLE 8-4 (CONTINUED)

Location of Structure Adjacent to Alignment		Type of Structure (N)	Transit Structure	Horiz. Distance from Near Track ¢ (ft)	Operat'l Train Speed (mph)	Ground-Borne Vibration: Criterion for Allowable Vibration Level (dB)*	Projected Maximum Vibration Veloc. Lvl. (dB)*	Projected Maximum Vibration Veloc. Lvl. With Recomm. Mitigation (dB)*
77+00 to 91+50	(OB)	Residential (13)	D/C&C	25	50	70	73-78	69-74[1]**
91+50 to 96+00	(OB)	Residential (8)	B&T	25	50	70	74-79	65-70[3]
96+00 to 103+00	(OB)	Residential (13)	B&T	25	50 @ x-over	70	84-89	65-70[3,5]
96+00 to 103+00	(IB)	Residential (5)	B&T	100	50 @ x-over	70	73-78	54-59[3,5]
103+00 to 109+00	(OB)	Residential (10)	B&T	25	50	70	74-79	65-70[3]
109+00 to 116+00	(OB)	Residential (8)	B&T	20	50	70	75-80	66-71[3]
NORTH CONCORD/MARTINEZ STATION Connection to LRT)								
390+00 to 393+00	(OB)	Residential (3)	B&T	125	60 @ x-over	75	67-72	--
656+00 to 754+00	(IB/OB)	Residential/ Apartments (75)	B&T	100	60	75	60-65	--
678+00 to 688+00	(OB)	Kaiser Medical Center	B&T	150	60 @ x-over	70	62-67	--

TABLE 8-4 (CONTINUED)

Location of Structure Adjacent to Alignment		Type of Structure (N)	Transit Structure	Horiz. Distance from Near Track ℄ (ft)	Operat'l Train Speed (mph)	Ground-Borne Vibration: Criterion for Allowable Vibration Level (dB)*	Ground-Borne Vibration: Projected Maximum Vibration Veloc. Lvl. (dB)*	Ground-Borne Vibration: Projected Maximum Vibration Veloc. Lvl. With Recomm. Mitigation (dB)*
838+00 to 841+00	(IB)	Residential (2)	A	75	60	75	57-62	--

Key:
A = Aerial structure
B&T = At-Grade ballast and tie
D/C&C = Depressed and cut-and-cover
x-over = Crossover
(N) = Number of buildings ± 10%
** = See text
* = dB re: 1 micro in/sec

Vibration Reduction Measures

1 Special resilient fasteners
2 Ballast mat
3 Floating ballast tub
4 Guideway/column isolator
5 Special switch frog

9. VEHICLE TRAFFIC AND HOV NOISE AND IMPACT ANALYSIS FOR ALTERNATIVES 1, 2 AND 3

9.1 Traffic Related Noise

Based on projections of traffic for the roads and highways in the Corridor area, the amount of traffic is projected to increase significantly between 1988 and 2000. In some areas the peak hour volumes will at least double compared with existing traffic. This will result in a noticeable increase in the noise exposure levels of approximately 3 dBA for those parts of the Corridor community adjacent to major transportation routes (e.g., Highway 4).

With construction of any of the Pittsburg-Antioch Corridor Alternatives, traffic analysis shows that there would be only minor differences between the various alternatives. The maximum difference in traffic volumes during the peak hour are less than 15 percent on Port Chicago Highway and less than 5 percent on Highway 4 west of Willow Pass Road. These differences will not significantly affect noise levels, since traffic volume would need to increase by 100 percent before an increase in noise levels would be noticeable.

The change in traffic patterns around proposed stations would primarily consist of an increase in local peak hour traffic and an increase in feeder buses. The resulting total change in automobile traffic would not cause a significant change in the cumulative noise levels.

9.2 Alternative 1 (No Build)

This alternative consists of the existing and programmed highway and transit system improvements. The significant changes over the existing conditions are closer peak period headways on the BART Concord line and the addition of one to two lanes to I-680 in both directions between Martinez and Alameda/Contra Costa County line. In addition, there are proposed minor changes in both BART Express Bus and Tri-Delta Transit bus operations.

The reduction in peak period headways on the BART Concord line will result in 2 dBA increase in peak hour L_{eq} and less than a 3 dBA increase in L_{dn} for communities adjacent to the existing Concord BART line. Based on the UMTA criteria, this would indicate that noise impacts are generally not significant.

Widening of Port Chicago Highway to four lanes is anticipated by the City of Concord as being necessary to accommodate increased future traffic levels. Traffic levels are expected to double by the year 2000 in the region resulting in an increase in noise levels adjacent to the highway and in the local community. Widening of the highway will also move traffic noise sources closer to homes in this area. The combined effect of these two factors would be an estimated 2 to 3 dBA increase in the ambient noise levels relative to the existing condition. Based on UMTA criteria, this would indicate insignificant impact.

However, the projected ambient noise exposure level for the homes along Port Chicago Highway is 65 to 67 dBA L_{dn} in the year 2000, based on existing ambient levels and projected traffic volumes and widening of the highway. This noise level is significantly above the 60 dBA noise goal set by Concord for single family residences as being acceptable. It is possible that the city may want to construct a sound barrier wall along the highway to reduce noise levels.

Widening of I-680 freeway is part of the State Transportation Improvement Plan (STIP) and is considered to be the responsibility of CALTRANS. Noise impacts due to widening and increased traffic would normally be analyzed as part of a STIP EIR analysis.

9.3 Alternative 2 (TSM)

This alternative calls for reducing headways and several routing modifications for all three bus lines serving the Corridor area. Also, some routes may be added where demand is needed. Exact details of specific modifications are not currently available at this time and a detailed analysis of noise impact is not possible.

Where possible, new bus routes should use heavily travelled routes to avoid significant increases in noise. This is planned for BART Express feeder buses which are to be re-oriented to highways. For reduction in headways (i.e., more frequent bus passbys), individual routes would need to be examined in more detail. In general, reducing headways by one-half will have a noticeable impact (increased noise) on more moderately travelled streets. Consequently, where possible, major headway changes should be made to routes where existing traffic is or will be heavy.

9.4 Alternative 3 (Busway/HOV)

The HOV alternative would primarily involve providing exclusive or semi-exclusive lanes for buses and for private vehicles used for car-pooling. The initial section of the route would be along city streets in Concord, which are already heavily travelled. Additional buses running through downtown Concord would have a minor impact in terms of additional noise exposure on the commercial and office building occupants in this area.

On Highway 242 and Highway 4, the presence of an existing large volume of heavy truck traffic means that the additional express buses would have an insignificant impact on the adjacent communities. The increase in heavy vehicle traffic at peak hour times with the addition of HOV is no more than 10 percent. The reduction of highway traffic due to car-pooling and bus patronage is projected to be minor enough to cause no noticeable reduction in traffic noise.

Construction of the express lanes in the highway median is expected to have a noticeable, but short-term impact on the adjacent community. Criteria for noise emission from construction equipment can be used to minimize this impact.

10. CONSTRUCTION NOISE AND VIBRATION IMPACT

One of the impacts associated with a rail rapid transit system project is the short-term effects of noise and vibration from construction activities. As with any large project, the construction of a rapid transit system involves the use of machines and procedures which, in the past, have resulted in intense noise levels and occasionally, high vibration levels in and around the construction site.

The control of noise and vibration during the construction of a Pittsburg-Antioch Corridor rail transit alignment or during road construction is important to minimize adverse impact on the neighboring community. This is particularly true because sections of the proposed rail alignments are located very close to a number of existing residential buildings, especially in Concord.

There are numerous procedures available for reducing the noise generated by construction equipment activities. One of the most effective methods of assuring controlled noise and minimum acoustic impact is the inclusion of noise limit specifications in the construction contract documents. Recent construction projects of BART, NYCTA, WMATA, and MARTA systems have included noise restrictions in the contract specifications.

Criteria for construction noise and vibration control in a format appropriate for inclusion in construction contracts documents should be developed in the engineering phase. The specification should require the construction contractor to comply with state and local ordinances, regulations, and other sections of the criteria document. Application of noise and vibration control specifications will minimize intrusion during the construction phases of the project.

GLOSSARY AND SIGNIFICANCE OF ACOUSTICAL TERMS

1. Glossary of Terms

A-WEIGHTED SOUND LEVEL (dBA):
The sound pressure level in decibels as measured on a sound level meter using the internationally standardized A-weighting filter or as computed from sound spectral data to which A-weighting adjustments have been made. A-weighting de-emphasizes the low and very high frequency components of the sound in a manner similar to the response of the average human ear. A-weighted sound levels correlate well with subjective reactions of people to noise and are universally used for community noise evaluations.

ACCELEROMETER:
A vibration sensitive transducer that responds to the vibration acceleration of a surface to which it is attached. The electronic signal generated by an accelerometer is directly proportional to the surface acceleration.

ACCELERATION LEVEL:
Also referred to as "vibration acceleration level." Vibration acceleration is the rate of change of speed and direction of a vibration. An accelerometer generates an electronic signal that is proportional to the vibration acceleration of the surface to which it is attached. The acceleration level is 20 times the logarithm to the base 10 of the ratio of the RMS value of the acceleration to a reference acceleration. The generally accepted reference vibration acceleration is 10^{-6} g (10^{-5} m/sec).

AMBIENT NOISE:
The prevailing general noise existing at a location or in a space, which usually consists of a composite of sounds from many sources near and far.

BACKGROUND NOISE:
The general composite non-recognizable noise from all distant sources, not including nearby sources or the source of interest. Generally background noise consists of a large number of distant noise sources and can be characterized by L_{90} or L_{99}.

COMMUNITY NOISE EQUIVALENT LEVEL (CNEL):
The L_{eq} of the A-weighted noise level over a 24-hour period with a 5 dB penalty applied to noise levels between 7 p.m. and 10 p.m. and a 10 dB penalty applied to noise levels between 10 p.m. and 7 a.m.

DAY-NIGHT SOUND LEVEL (L_{dn}):
The L_{eq} of the A-weighted noise level over a 24-hour period with a 10 dB penalty applied to noise levels between 10 p.m. and 7 a.m.

DECIBEL (dB):
The decibel is a measure on a logarithmic scale of the magnitude of a particular quantity (such as sound pressure, sound power, sound intensity) with respect to a standardized reference quantity.

ENERGY EQUIVALENT LEVEL (L_{eq}):
The level of a steady noise which would have the same energy as the fluctuating noise level integrated over the time period of interest. L_{eq} is widely used as a single-number descriptor of environmental noise. L_{eq} is

based on the logarithmic or energy summation and it places more emphasis on high noise level periods than does L_{50} or a straight arithmetic average of noise level over time. This energy average is not the same as the average of sound pressure levels over the period of interest, but must be computed by a procedure involving summation or mathematical integration.

FREQUENCY (Hz):
The number of oscillations per second of a periodic noise (or vibration) expressed in Hertz (abbreviated Hz). Frequency in Hertz is the same as cycles per second.

L_1, L_{10}, L_{50}, L_{90} AND L_{99}:
The noise (or vibration) levels that are exceeded for 1%, 10%, 50%, 90% and 99% of a specified time period, respectively. Environmental noise and vibration data are often described in these terms. See section G-2 for a more detailed discussion of the statistical distribution terms.

NOISE REDUCTION COEFFICIENT (NRC):
Noise reduction coefficient is a measure of the acoustical absorption performance of a material, calculated by averaging its sound absorption coefficients at 250 Hz, 500 Hz, 1000 Hz and 2000 Hz.

OCTAVE BAND - 1/3 OCTAVE BAND:
One octave is an interval between two sound frequencies that have a ratio of two. For example, the frequency range of 200 Hz to 400 Hz is one octave, as is the frequency range of 2000 Hz to 4000 Hz. An octave band is a frequency range that is one octave wide. A standard series of octaves is used in acoustics, and they are

specified by their center frequencies. In acoustics, to increase resolution, the frequency content of a sound or vibration is often analyzed in terms of 1/3 octave bands, where each octave is divided into three 1/3 octave bands.

REVERBERANT FIELD:
The region in a room where the reflected sound dominates, as opposed to the region close to the noise source, where the direct sound dominates.

REVERBERATION:
The continuation of sound reflections within an enclosed space after the sound source has stopped.

REVERBERATION TIME (RT):
The time taken for the sound-pressure level in a room to decrease to one-millionth (60 dB) of its steady state value after the source of sound energy is suddenly interrupted. It is a measure of the persistence of a sound in a room and of the amount of acoustical absorption present inside the room.

SOUND ABSORPTION COEFFICIENT (α):
The absorption coefficient of a material is the ratio of the sound absorbed by the material to that absorbed by an equivalent area of open window. The absorption coefficient of a perfectly absorbing surface would be 1.0 while that for concrete or marble slate is approximately 0.01 (a perfect reflector would have an absorption of 0.00).

SOUND PRESSURE LEVEL (SPL):
The sound pressure level of a sound in decibels is 20 times the logarithm to the base of 10 of the ratio of the RMS value of the sound pressure to the RMS value of a reference sound pressure. The standard reference sound pressure is 20 micro-pascals as indicated in ANSI S1.8-1969, "Preferred Reference Quantities for Acoustical Levels".

VELOCITY LEVEL:
Also referred to as the "vibration velocity level." Vibration velocity is the rate of change of displacement of a vibration. The velocity level is 20 times the logarithm to the base 10 of the ratio of the RMS value of the velocity to the reference velocity. In this report the reported vibration velocity levels are all referenced to 10^{-6} in/sec. Above approximately 10 Hz, human response to vibration is more closely correlated to the velocity level than the acceleration level.

WEIGHTED VELOCITY LEVEL:
The vibration velocity level to which a weighting factor has been added. The weighting de-emphasizes the low frequencies in a manner similar to human response to vibration. The weighting used in this report is based on that proposed in Reference 7, however, there is no internationally recognized velocity weighting filter.

2. Statistical Distribution Terms

L_{99} and L_{90} are descriptors of the typical minimum or "residual" background noise (or vibration) levels observed during a measurement period, normally made up of the summation of a large number of sound sources distant from

the measurement position and not usually recognizable as individual noise sources. The most prevalent source of this residual noise is distant street traffic. L_{99} and L_{90} are not strongly influenced by occasional local motor vehicle pass-bys. However they can be influenced by stationary sources such as air conditioning equipment.

L_{50} represents a long-term statistical median noise level over the measurement period and does reveal the long-term influence of local traffic.

L_{10} describes typical levels or average for the maximum noise levels occurring, for example, during nearby passbys of trains, trucks, buses and automobiles, when there is relatively steady traffic. Thus, while L_{10} does not necessarily describe the typical maximum noise levels observed at a point, it is strongly influenced by the momentary maximum noise level occurring during vehicle passbys at most locations.

L_1, the noise level exceeded for 1% of the time is representative of the occasional, isolated maximum or peak level which occurs in an area. L_1 is usually strongly influenced by the maximum short-duration noise level events which occur during the measurement time period and are often determined by aircraft or large vehicle passbys.

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Appendix E
Air Quality

PITTSBURG-ANTIOCH CORRIDOR
ADDITIONAL AIR QUALITY DATA

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June 1988

AIR QUALITY DATA

E.1 INTRODUCTION

This technical appendix presents additional background information for the air quality sections of the Pittsburg-Antioch Corridor AA/DEIR. Included in the appendix are air quality data collected from three monitoring stations in the corridor, input data from the computer modeling of potential impacts, and modeling assumptions.

E.2 METEOROLOGICAL DATA

The distribution of wind direction and wind speed at two meteorological monitoring stations (Pittsburg and Concord) is depicted in Exhibits E-1 and E-2. These two wind roses show great similarities with predominant wind direction from the southwest. The wind speed rarely exceeds 18 miles per hour.

E.3 AIR QUALITY DATA

Air quality data collected at three monitoring stations in the Corridor are presented in Tables E-1 (Bechtel Island Road Station), E-2 (Concord Station), and E-3 (Pittsburg Station). It should be noted that PM-10 data are available at two sites: at the Bechtel Island Road Station since 1985 and at the Concord Station since 1986.

E.4 IMPACT METHODOLOGY

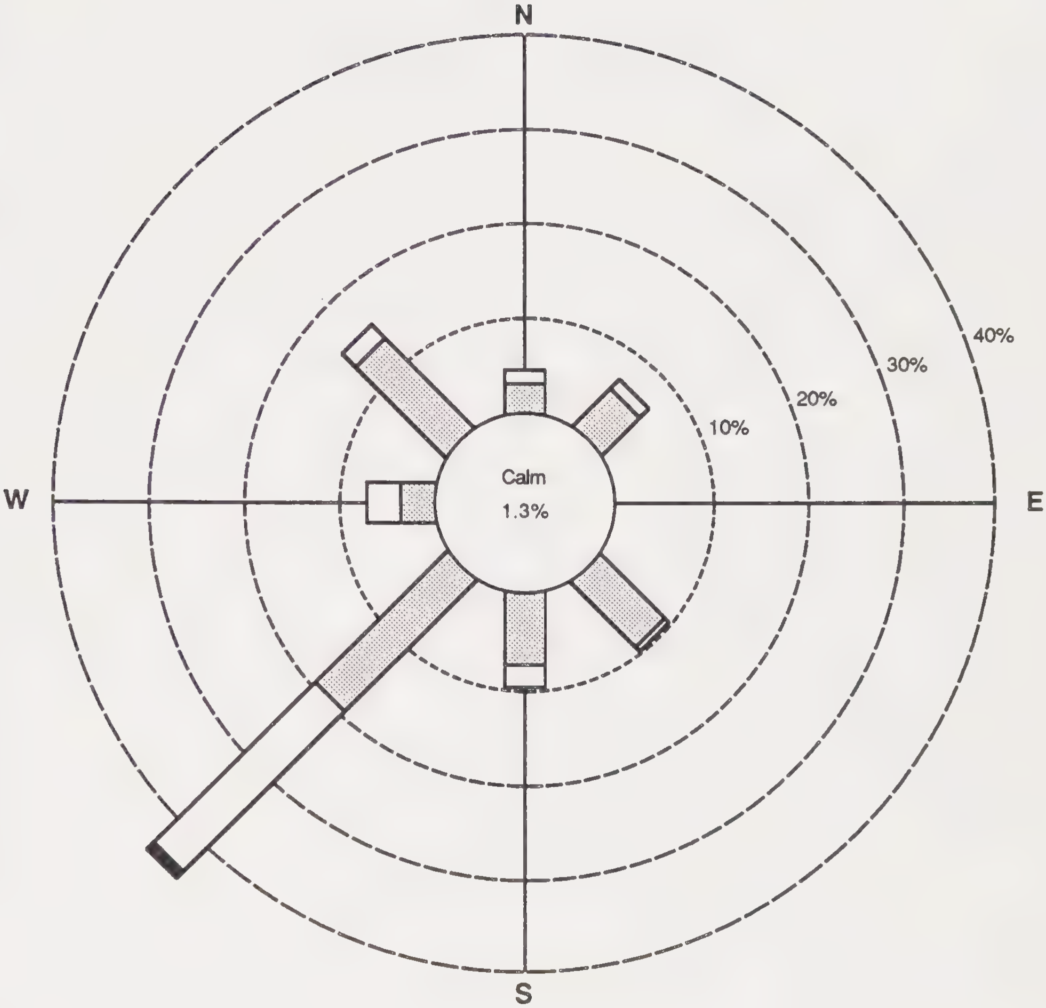
The purpose of this study was to evaluate the relative differences between air quality impacts from changing traffic patterns due to transportation alternatives. These alternatives range from a no build option to various BART routing options. Air quality impacts were predicted for the year 2000 at BART stations in the Pittsburg-Antioch Corridor area. These were the Bailey Road Station, the Railroad Avenue Station, and the Hillcrest Avenue Station.

TABLE E-1

MEASURED MAXIMUM AMBIENT POLLUTANT CONCENTRATIONS AT THE BECHTEL ISLAND ROAD MONITORING STATION

POLLUTANT	AVERAGING TIME	YEAR 1984	1985	1986
Carbon Monoxide (ppm)	8 Hour Average	1.3	1.3	1.3
	1 Hour Average	3.0	8.0	2.0
Ozone (ppm)	1 Hour Average	0.14	0.13	0.12
Nitrogen Dioxide (ppm)	Annual Average	0.015	0.014	0.015
	1 Hour Average	0.07	0.06	0.06
Sulfur Dioxide (ppm)	Annual Average	0.001	0.001	0.000
	24 Hour Average	0.009	0.010	0.006
	1 Hour Average	0.01	0.02	0.01
Particulate Matter (PM-10) (ug/m^3)	Annual Average (Arithmetic Mean)	--	33.4	28.6
	Annual Average	--	29.6	26.0(Geometric Mean)
	24 Hour Average	--	71.0	80.0
Lead (ug/m^3)	Calendar Quarter Average	0.13	0.08	0.05
	30 Day Average	0.13	0.15	0.07

Source: California Air Resources Board, 1985, 1986, 1987.



Source: Bay Area Air Quality Management District, San Francisco, CA

Annual Wind Rose For The Pittsburg Monitoring Station

Pittsburg Antioch Corridor AA/DEIR

Wind speed distribution

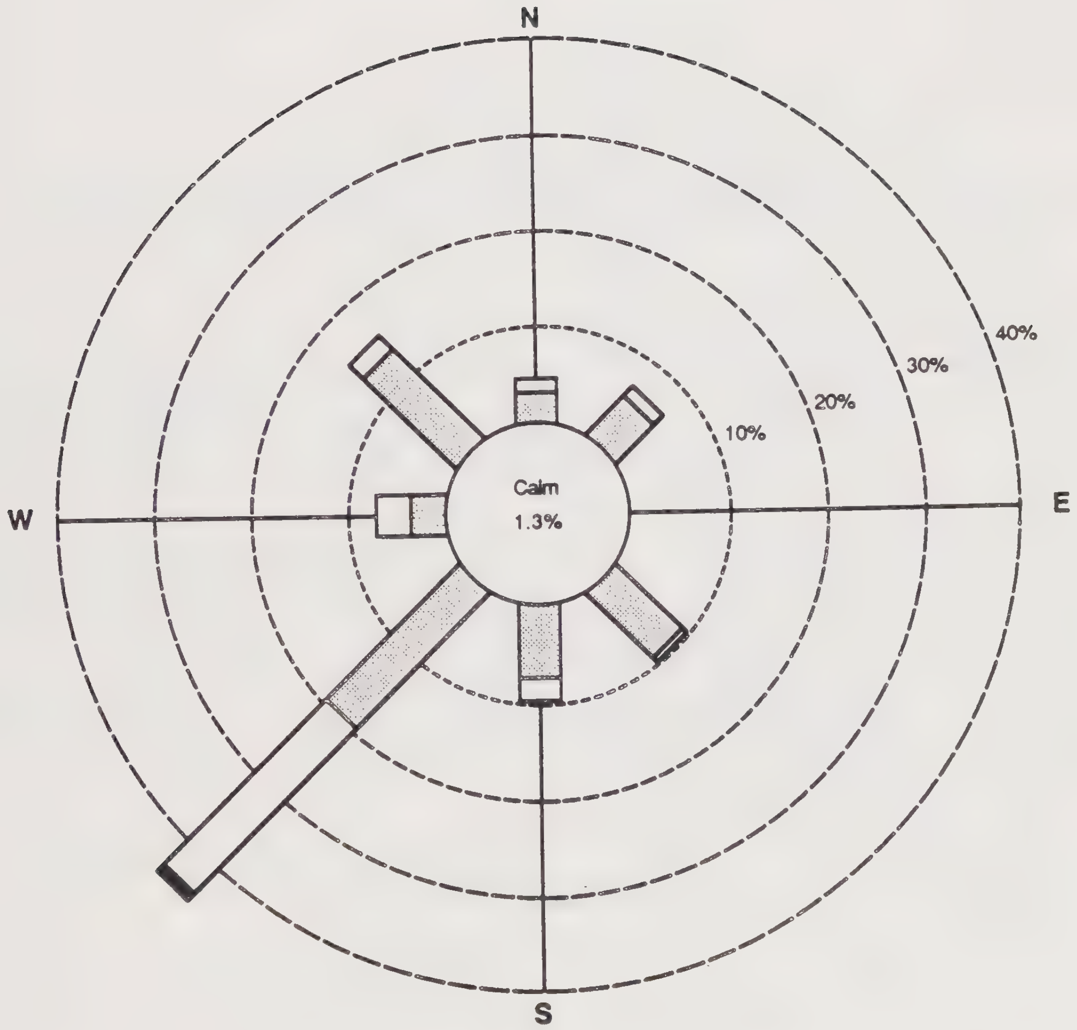
1 - 7   8 - 18   >18 mph

North

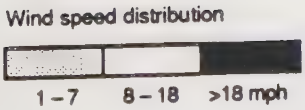
NO SCALE

BART

Exhibit E-1



Source: Bay Area Air Quality Management District, San Francisco, CA



Annual Wind Rose For
The Concord Monitoring Station

Pittsburg-Antioch Corridor
AA/DEIR

North

NO SCALE

BART

Exhibit E-2

TABLE E-2

MEASURED MAXIMUM AMBIENT POLLUTANT
CONCENTRATIONS AT THE CONCORD MONITORING STATION

POLLUTANT	AVERAGING TIME	YEAR 1984	1985	1986
Carbon Monoxide (ppm)	8 Hour Average	5.9	5.3	5.6
	1 Hour Average	12.0	11.0	10.0
Ozone (ppm)	1 Hour Average	0.14	0.15	0.12
Nitrogen Dioxide (ppm)	Annual Average	0.024	0.023	0.023
	1 Hour Average	0.10	0.10	0.11
Sulfur Dioxide (ppm)	Annual Average	0.000	0.000	0.000
	24 Hour Average	0.012	0.025	0.010
	1 Hour Average	0.07	0.18	0.05
Particulate Matter (PM-10) (ug/m^3)	Annual Average (Arithmetic Mean)	- -	- -	26.6
	Annual Average (Geometric Mean)	- -	- -	23.0
	24 Hour Average	- -	- -	86.0
Lead (ug/m^3)	Calendar Quarter Average	0.30	0.16	0.10
	30 Day Average	0.43	0.22	0.14

Source: California Air Resources Board, 1985, 1986, 1987.

TABLE E-3

MEASURED MAXIMUM AMBIENT POLLUTANT
CONCENTRATIONS AT THE PITTSBURG MONITORING STATION

POLLUTANT	AVERAGING TIME	YEAR 1984	1985	1986
Carbon Monoxide (ppm)	8 Hour Average	4.9	3.8	5.6
	1 Hour Average	8.0	9.0	9.0
Ozone (ppm)	1 Hour Average	0.16	0.14	0.10
Nitrogen Dioxide (ppm)	Annual Average	0.018	0.018	0.018
	1 Hour Average	0.07	0.09	0.09
Sulfur Dioxide (ppm)	Annual Average	0.001	0.000	0.001
	24 Hour Average	0.050	0.008	0.007
	1 Hour Average	0.18	0.03	0.04
Particulate Matter (PM-10) (ug/m^3)	Annual Average (Arithmetic Mean)	--	--	--
	Annual Average (Geometric Mean)	--	--	--
	24 Hour Average	--	--	--
Lead (ug/m^3)	Calendar Quarter Average	0.28	0.14	0.11
	30 Day Average	0.35	0.17	0.14

Source: California Air Resources Board, 1985, 1986, 1987.

To evaluate these impacts the California Line Source Dispersion Model[1], CALINE4, was used. CALINE4 is the latest in a series of line source air quality models developed by the California Department of Transportation (Caltrans). It is based on the Gaussian diffusion equation and employs a mixing zone concept to characterize pollutant dispersion over the roadway. The model uses traffic emissions, site geometry, and meteorology to predict air pollutant concentrations near roadways. Predictions can be made for carbon monoxide (CO), nitrogen dioxide (NO2), and suspended particles. Options for modeling near intersections, parking lots, elevated or depressed freeways, and within city canyons are provided.

The model, as used, was implemented in BASIC on an IBM PC microcomputer. This version of CALINE4 was supplied by the California Air Resources Board as part of their Air Quality Analysis Tools program package[2]. Included in the same program package was another program, EMFAC7PC, which was used to estimate emissions from vehicles in the study area. EMFAC7PC provides emission projections based on State of California assumptions for a typical California vehicular fleet mix.

E.4.1 INPUT DATA

Vehicle Volumes

The primary data used to evaluate the seven alternatives studied consisted of estimates of traffic volume in the study area for the year 2000. Data were provided[3] for various sections of roadways links along State Route 4 and arterial freeways in close proximity to each of the three proposed BART stations. These data are estimates of morning peak hourly traffic volumes and an estimated speed through each link for State Route 4 and a level of service (LOS) rating for each arterial link. The average speed through each arterial link was estimated based on Table E-4. These data were taken from available information[4] sources assuming the lowest reasonable speed for each LOS.

TABLE E-4
LEVEL OF SERVICE AND TRAVEL SPEED

Level of Service	Average Travel Speed (mph)
A	30
B	25
C	20
D	15
E	10
F	5

Meteorology

CALINE4 provides estimates of hourly concentrations along roadways. These can be produced for various atmospheric conditions of wind speed, wind direction, ambient air temperature, mixing height, Pasquill stability class, and standard deviation of wind bearing. The specific meteorological input to CALINE4 in this study was assumed to be the worst case for an urban environment. The values used are as follows:

Wind Speed	1.0 m/sec
Wind Direction	see modeling assumptions section
Ambient Air Temperature	40° F
Mixing Height	1000 m
Stability Class	D
Standard Deviation of Wind Bearing	20 Degrees

These values were selected based on modeling guidance from available sources[1,2,5].

Emissions

Emissions resulting from operation of vehicles on near each proposed BART station were estimated using the CARB's EMFAC7PC computer program. This program is similar to the U.S. Environmental Protection Agency's MOBILE 3 emission program. The primary difference between MOBILE 3 and EMFAC7PC is the use of California specific emission factors in EMFAC7PC.

Specific information about the local fleet mix of vehicle type and fuel mix was unavailable for this study. Thus, the standard vehicle fleet mix provided by EMFAC7PC was used. Emission estimates were based on the study time period for the year 2000. EMFAC7PC requires the user to assume values for percent of hot and cold start for vehicle miles traveled. These data were unavailable. Emission guidance from the Federal Highway Administration[6] (FHWA) suggests use of 20.6 and 27.3 percent for a cold and hot start mix in an urban environment, respectively. these values were used in this study. FHWA guidance further suggests, in the case of CO emissions, that emissions should be estimated for the worst case air quality month in the area. This is due to the relationship of CO production to atmospheric temperature. At cold and hot temperature extremes more CO is produced than at EMFAC7PC's default value of 75° F. In the Pittsburg-Antioch area the worst case month is December with typical low temperatures between 34° F to 36° F. This information was obtained from a personal communication with the Bay Area Air Quality Management District. Since the vehicle volume data represents peak morning hour traffic conditions, an atmospheric air temperature of 40° F was assumed to represent worst case conditions for CO production.

Based on the above assumptions and data, the following are the emission factors used in this study produced by EMPAC7PC:

TABLE E-5

EMFAC7PC EMISSION FACTORS
VERSION: EMFAC7PC 1/4/87

YEAR: 2000
PERCENT VMT COLD: 20.6

TEMPERATURE: 40 F
PERCENT VMT HOT: 27.3
GRAMS PER MILE

Speed	TOG	CO	NOX
5 MPH	4.80	59.59	2.35
10 MPH	3.59	46.19	2.08
15 MPH	2.77	36.37	1.90
20 MPH	2.18	28.89	1.77
25 MPH	1.76	23.10	1.69
30 MPH	1.45	18.58	1.65
35 MPH	1.22	15.04	1.64
40 MPH	1.05	12.27	1.66
45 MPH	0.91	10.12	1.73
50 MPH	0.82	8.47	1.82
55 MPH	0.74	7.25	1.96

Idle Emission Factors	
Total Organic Gases	0.14 Grams/Minute
Carbon Monoxide	1.61 Grams/Minute
Nitrogen Oxide	0.15 Grams/Minute

Source: EMFAC7PC computer program, Ref. 2.

E.4.2 MODELING ASSUMPTIONS

Wind Direction

CALINE4 allows the user to analyze for either a "normal" run or "worst case" run. The normal run requires a single wind direction to be input. The worst case run ignores any input wind direction and calculates, to the nearest one degree of wind direction, the maximum concentration at each receptor resulting from all input link emissions. In this study all alternative/stations were analyzed for worst case wind direction conditions.

Link Data

CALINE4 allows the user to specify links as one of six classes: at-grade, fill, depressed section, bridge, parking lot, and lot, and intersection. In this study all links were modeled as at grade, bridge, or intersection. The at grade links were assumed to be at height 0 m. The bridge links were assumed to be at 6 m. The intersection links were assumed to be at 0 m and each intersection link was assumed to be 100 m long. All data on link width and traffic light timing frequencies were based on visual inspection of the roadways as they existed in May 1988.

E.4.3 PREDICTED IMPACTS

The predicted air quality impacts from CALINE4 at the Bailey Road Station, the Railroad Avenue Station, and the Hillcrest Avenue Station are presented in Tables E-6 and E-7. These results do not include ambient background concentrations. Note that the 8 hour values were estimated from the hourly concentrations by use of a conversion factor of 0.7[7].

TABLE E-6

MAXIMUM HOURLY CONCENTRATIONS OF CO IN PPM BY ALTERNATIVE (YEAR 2000)

Alternative	Bailey Avenue Station	Railroad Avenue Station	Hillcrest Avenue Station
1	1.5	1.9	0.7
2	1.4	1.9	0.7
3	1.5	1.9	0.7
4	1.5	1.9	0.7
5	1.5	1.9	0.7
6	1.5	1.9	0.7
7	1.5	1.9	0.7

TABLE E-7

MAXIMUM 8-HOUR CONCENTRATIONS OF CO IN PPM BY ALTERNATIVE (YEAR 2000)

Alternative	Bailey Avenue Station	Railroad Avenue Station	Hillcrest Avenue Station
1	1.1	1.3	0.5
2	1.0	1.3	0.5
3	1.1	1.3	0.5
4	1.1	1.3	0.5
5	1.1	1.3	0.5
6	1.1	1.3	0.5
7	1.2	1.3	0.5

These data show that at each of the stations there is little or no change in the predicted air quality impact due to different traffic flow volumes produced by each alternative.

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Appendix F

Traffic Analysis Volumes and Assumptions

PITTSBURG-ANTIOCH CORRIDOR ADDITIONAL TRAFFIC ANALYSIS VOLUMES AND ASSUMPTIONS

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July 1988

TRAFFIC ANALYSIS VOLUMES AND ASSUMPTIONS

The volumes calculated to represent 1987 operating conditions and used to derive the year 2000 traffic forecasts at roadways adjacent to transit stations and park-and-ride lots are shown in Table F-1. Local jurisdictions provided counts for the 1982-1987 period, which were then extrapolated to 1987 based on annual growth factors derived by MTC's travel forecasts for the same groups of roadways for 1980 and 2000.

The existing intersection volumes for the North Concord and Concord station areas are shown in Exhibit F-1. The roadway capacities used to calculate levels of service are shown in Table F-2, and the level of service definitions are presented in Table F-3. The changes and improvements assumed for the analysis of roadways in downtown Concord are shown in Table F-4.

TABLE F-1
1987 TRAFFIC VOLUMES ON SELECTED ROADWAYS

	One-Way, Peak Hour Peak Direction Volumes AM	PM	Daily Two-Way Traffic Volumes
West Pittsburg Station			
Bailey north of Leland	896	946	8,078
Bailey south of Canal Road	856	873	12,262
Bailey south of Willow Pass	656	512	6,294
Willow Pass east of Port Chicago	1,415	1,164	10,095
Willow Pass west of Bailey	1,317	916	10,974
Willow Pass east of Bailey	737	726	7,702
Pittsburg Station			
Railroad south of E. Leland	811	1,008	12,753
E. Leland east of Railroad	494	607	7,032
E. Leland west of Railroad	920	779	9,166
Railroad north of Bliss	1,197	1,434	18,394
Bliss east of Railroad	248	313	3,637
Railroad on the overpass	855	1,153	14,055
Railroad north of California	870	1,216	14,977
Power (Center) west of Railroad	190	233	2,852
Solari north of Central		665	13,306
Central west of Solari		716	14,310
Harbor north of California	611	602	7,286
California west of Harbor	471	414	2,841
California east of Harbor	919	655	9,414
Harbor north of Leland	523	621	7,829
Harbor south of Leland	541	614	8,327
E. Leland east of Harbor	764	667	7,545
West Antioch Station			
Somersville south of Delta Fair	577	1,464	15,044
Somersville north of Delta Fair	577	1,464	15,044
Somersville south of Century	460	1,084	13,264
Somersville north of Century	363	743	8,790
Somersville south of 10th	247	578	5,852
A Street Station (Alt. 4 Only)			
A Street south of 18th	584	800	10,055
A Street north of Bryon	520	1,152	10,726
A Street south of Bryon	690	1,192	11,776
East Antioch Station			
Hillcrest south of Larkspur	461	550	7,729
Hillcrest north of Larkspur	624	872	9,491
Hillcrest south of 18th	199	324	3,508

Source: Barton-Aschman Associates, Inc. based on counts supplied by Antioch, Concord, Pittsburg, and Contra Costa County.

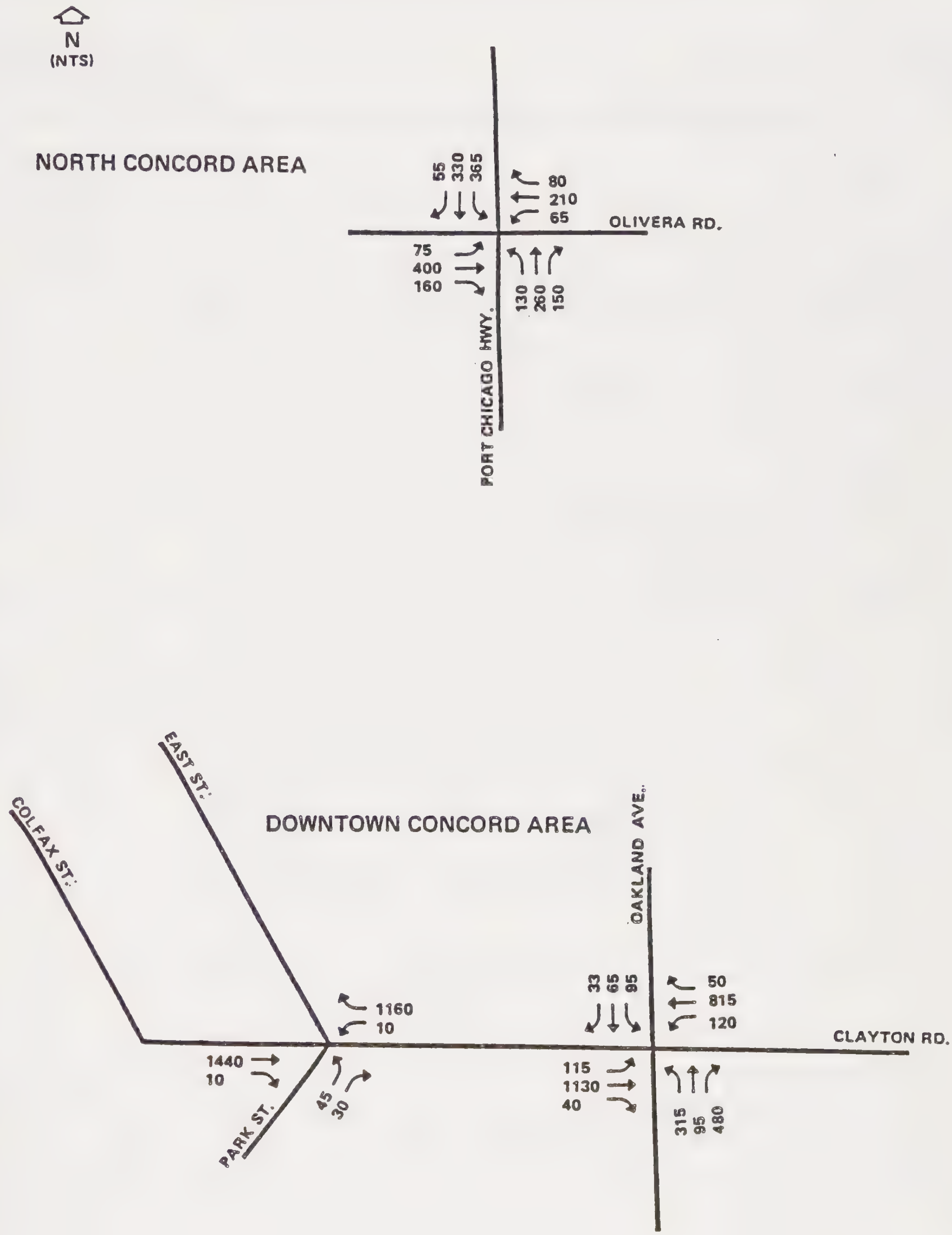

Exhibit F-1

EXISTING INTERSECTION VOLUMES

(PM PEAK HOUR)

Barton-Aschman Associates, Inc.

TABLE F-2
ROADWAY CAPACITIES

	ADT	Peak Hour Two-Way	Peak Hour One-Way
4-Lane Divided Arterial (W/Left-Turn Lanes)	32,000	3,200	1,900
4-Lane Undivided Arterial (W/Left-Turn Lanes)	30,000	3,000	1,800
4-Lane Undivided Arterial (No Lefts)	24,000	2,400	1,400
2-Lane Arterial (W/Lefts)	15,000	1,500	900
2-Lane Collector	12,000	1,200	700

Source: 1985 Highway Capacity Manual.

TABLE F-3
LEVEL-OF-SERVICE CRITERIA

Level of Service	Description	Volume to Capacity Ratio
A	Operations with very low delay occurring with favorable progression and/or short cycle lengths.	Less than 0.60
B	Operations with low delay occurring with good progression and/or short cycle lengths.	0.61 to 0.70
C	Operations with average delays resulting from fair progression and/or longer cycle lengths. Individual cycle failures begin to appear.	0.71 to 0.80
D	Operations with longer delays due to a combination of unfavorable progression, long cycle lengths, or high V/C ratios. Many vehicles stop and individual cycle failures are noticeable.	0.81 to 0.90
E	Operations with high delay values indicating poor progression, long cycle lengths, and high V/C ratios. Individual cycle failures are frequent occurrences. This is considered to be the limit of acceptable delay.	0.91 to 1.00
F	Operations with delays unacceptable to most drivers occurring due to oversaturation, poor progression, or very long cycle lengths.	Greater than 1.00

Source: Transportation Research Board, Highway Capacity Manual, Special Report 209, (Washington, D.C., 1985) pp. 9-4 - 9-5.

TABLE F-4
FUTURE DOWNTOWN CONCORD ROADWAY IMPROVEMENTS

Project
Concord Avenue/Galindo Street Market to Willow Pass, Phase 2: Construct 6-lane roadway with double left-turn lanes at Pacheco Street and S.R. 242 on-ramp.
Galindo Street, Willow Pass to Laguna/Oak, Phase 3: Construct 6-lane roadway with double lefts at Clayton Road and Concord Boulevard.
Galindo Street/Monument Boulevard, Laguna/Oak to Walters/Systron, Phase 1: Construct 6-lane roadway with double lefts at Cowell Road.
Concord Avenue and Market Street: Widen S.R. 242 on-ramp; widen off-ramp to 6 lanes at the intersections.
Port Chicago Highway and Sunset Extension: Construct 4-lane one-way Port Chicago Highway, Clayton to Bonifacio. Extend Sunset from East Street one-way to Concord Boulevard.
Clayton Road, Grant to Park: Construct large-radius curve for 3 lanes of Clayton traffic.
S.R. 242: Auxiliary lane and on-ramp NB from Broadway and Market.
S.R. 242: Widen SB off-ramp and add signal at Solano Way.
Clayton Road, Park Street to Farm Bureau Road: Construct 6-lane roadway with some double lefts.
Market Street, Willow Pass to Clayton: Add one SB lane as a right-turn lane and double lefts from off-ramp to Market.
S.R. 242: Off-ramp to Market Street and Sutter Street for NB.
Concord Boulevard: Widen to 4 lanes between N. 6th Street and Live Oak Drive, with turn lanes at major intersections.
Willow Pass and Farm Bureau/Olivera: Widen to provide added right-turn lane on Willow Pass EB, and added through lane on Olivera SB.

Note: NB, EB, SB, WB = northbound, eastbound, southbound, and westbound, respectively.

Source: City of Concord